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AFFDL-TR-77-83
Volume II

EXTENDED STUDY OF FLAW GROWTH AT FASTENER HOLES

Data Tabulation

LOCKHEED-GEORGIA COMPANY
MARIETTA, GEORGIA 30063

APRIL 1978

TECHNICAL REPORT AFFDL-TR-77-83, Volume II
Final Report for June 1975 – June 1977

AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE WRIGHT AERONAUTICAL LABORATORIES
AIR FORCE SYSTEMS COMMAND
WRIGHT-PATTERSON AIR FORCE BASE, OHIO 45433

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This technical report has been reviewed and is approved for publication.

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AFFDL-TR-78-56/AFWAL-TR-78-56/31 July 1978 - 500

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: AFFDL-TR-77-83-VOL II -2	2. GOVT ACCESSION NO. / 3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle): EXTENDED STUDY OF FLAW GROWTH AT FASTENER HOLES, DATA TABULATIONS Volume II	5. TYPE OF REPORT & PERIOD COVERED: Final Report, 10 June 1975 - 10 June 1977
	6. PERFORMING ORG. REPORT NUMBER: LG78ER0064 - Vol-2
7. AUTHOR(s): T. M. Hsu and W. M. McGee	8. CONTRACT OR GRANT NUMBER(s): F33615-75-C-3099
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Lockheed-Georgia Company, A Division of Lockheed Corporation, Marietta, Georgia 30063	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: Project No. 486U; Task No. 486U02; Work Unit No. 486U0212
11. CONTROLLING OFFICE NAME AND ADDRESS: Air Force Flight Dynamics Laboratory (AFFDL/FBE), Wright Patterson AFB, Ohio 45433	12. REPORT DATE: April 1978 / 13. NUMBER OF PAGES: 202
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): 155p.	15. SECURITY CLASS. (of this report): Unclassified / 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Stress Intensity Factors	Fastener System
Fastener Hole Flaws	Spectrum Loads
Fatigue Crack Growth	2219-T851 Aluminum
Natural Crack	6Al-4V βA(ELI) Titanium

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

An analytical and experimental investigation was conducted to characterize the fracture and cyclic-growth behavior of cracks emanating from various types of fastener holes, such as open, close-tolerance, interference-fit, and cold worked fastener holes. An analytical approach was developed for estimating stress intensity factors for through cracks emanating from these types of fastener holes. Approximate stress intensity factors for quarter-elliptical cracks emanating from a corner of the same types of fastener holes were derived from corresponding through-crack solutions. Two alloy plates (2219-T851 aluminum and 6Al-4V(ELI)

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beta annealed titanium) with and without intentional initial flaws were tested under constant amplitude cyclic load and flight-by-flight fighter and bomber spectrum loads. Two initial flaw shapes corresponding to a quarter-circular corner crack and a through-the-thickness crack and three initial crack lengths (small, intermediate and large) were used in the test program. Three levels of cold working and interference and one level of fastener load transfer were included for each alloy. The amount of load transferred through the loaded fastener was maintained uniformly at the level which produced a bearing stress equal to the far-field stress.

Correlations between calculated stress intensities and those reduced from fatigue crack growth data were good, except for very small cracks growing from the cold-worked holes. Also, the natural cracks initiated in the fatigue tests were most commonly corner and embedded types whose shapes corresponded quite closely to the quarter- and semi-elliptical shapes used in the analyses.

Test growth rates for holes with residual strains (cold-worked or interference-fit fasteners) were significantly slower than for straight reamed holes without any conditioning - especially for small initial cracks. This benefit decayed as crack length increased.

Data scatter was most apparent in fighter-spectrum tests and in the tests of short initial cracks propagating from cold worked and interference-fit holes. Another important feature observed was how the initial corner flaw shapes changed during their growth: for straight reamed holes with or without cold-working, the final dimension on the hole wall was almost always larger than the final dimension on the plate surface, especially for the cold-worked hole; for interference-fit fastener holes without fastener load transfer, the final flaw shape was close to quarter-circular; for interference-fit fastener holes with fastener load transfer, the final dimension on the hole wall was less than that on the plate surface.

Lastly, a review of experimental results and numerical predictions indicated the possibility that the beneficial residual compressive strains induced by cold-working operations were relaxed during the subsequent application of cyclic loads.

FOREWORD

This report describes results of work performed by the Lockheed-Georgia Company on Air Force Contract F33615-75-C-3099, "Extended Study of Flaw Growth at Fastener Holes." The effort was sponsored by the Air Force Flight Dynamics Laboratory as part of the Advanced Metallic Structures - Advanced Development Program, Project No. 486U. Mr. James L. Rudd of AFFDL/FBE was the Air Force Project Engineer.

This program was conducted within the Engineering Branch of the Lockheed-Georgia Company, Marietta, Georgia, under the direction of Chief Engineer - Research and Technology, Mr. H. B. Allison. The Project Engineer was Dr. T. M. Hsu of the Advanced Structures Department. The experimental work was performed under the supervision of W. M. McGee who was assisted by H. R. Michael. The stress intensity factor analysis and data evaluation were performed by Dr. T. M. Hsu. This is Volume II of the final technical report and contains tabulations of raw data generated during the experimental evaluations performed over the period of June 1975 - June 1977.

This report was submitted by the authors on November 10, 1977.

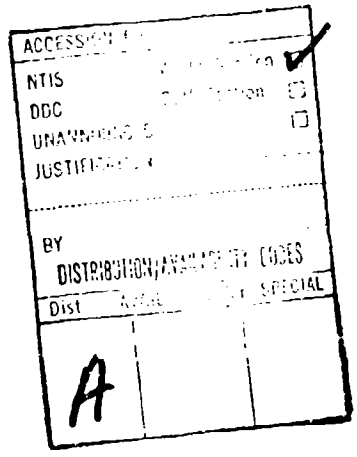

TABLE OF CONTENTS

LIST OF SYMBOLS

A	Aluminum
BS	Bomber spectrum
CA	Constant amplitude
c	Crack length on the Surface of the plate
CW	Cold-worked
FS	Fighter Spectrum
R	Stress ratio, $\sigma_{min}/\sigma_{max}$
T	Titanium
TL	Taper-Lok
σ_b	Bearing Stress at loaded fastener hole
σ_{max}	Maximum far-field applied stress
σ_o	Far-field applied uniform stress
δ	Amount of diametral expansion

SECTION I
INTRODUCTION

An analytical and experimental investigation was conducted under Air Force Contract No. F33615-75-C-3099 to characterize the fracture and cyclic growth behavior of small cracks emanating from various types of fastener holes. The detail results and discussions are presented in Volume I of USAF Technical Report AFFDL-TR-77-83. This report is the second volume of the aforementioned report. It contains tabulations of raw fatigue crack growth data generated during the efforts conducted over the period of June 1975 - June 1977.

Experimental data in the form of crack length versus number of load cycles (or flights) resulting from applications of constant amplitude loading and flight-by-flight spectrum loading were obtained for 370 different test holes on two different alloys, namely, 2219-T851 aluminum and 6Al-4V standard ELI beta annealed titanium. These test holes were distributed in 131 specimens (71 aluminum specimens and 60 titanium specimens).

The stress level used in the constant-amplitude load tests was approximately equal to one third of the material yield strength (18 ksi for aluminum specimens and 40 ksi for titanium specimens). Only the stress ratio of 0.1 was investigated in the constant amplitude tests. Two different spectra representative standard bomber and fighter operations were employed in the spectrum load tests. Two initial flaw shapes corresponding to the quarter-elliptical corner crack and the through-the-thickness crack and three initial crack lengths (small, intermediate and large)* were used in the test program. The test holes, including open, close tolerance, interference-fit, and cold-worked fastener holes, were subjected to the remote loading and possible also fastener loading. Three levels of cold-working and interference were included for each alloy. The amount of load transferred through the loaded fastener was maintained uniformly at the level which produces a bearing stress approximately equal to the far-field stress.

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*In this report, the crack size definitions are as follows:

Small:	0.005"	a	0.050"
Intermediate:	0.050"	a	0.150"
Large:		a	0.150"

Each table tabulated the crack length versus number of cycles (or flights) for all test holes in one specimen. The tables of such crack growth data are arranged in the same order as they are discussed in Volume I of this report. All pertinent informations are contained in the tables.

SECTION II
DATA TABULATIONS

1. CONSTANT AMPLITUDE LOAD TESTS

This section contains the crack growth data of both corner crack and thru crack emanating from open, close tolerance, interference-fit, and cold-worked fastener holes in both 2219-T851 aluminum and 6Al-4V beta annealed titanium specimens subjected to constant amplitude far-field loading.

1.1 2219-T851 Aluminum -Corner Cracks

TABLE 1 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-1,
THICKNESS (INCH) 0.4508,
WIDTH (INCH) 4.00,

HOLE #1 Neat-Fit with Load-Transfer, $\frac{\sigma_b}{\sigma_o} = 0.99$
HOLE #2 Neat-Fit, $\frac{\sigma_b}{\sigma_o} = 0$
HOLE #3 open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.004 ⚠	.003 ⚠	.003 ⚠	50,500	.113	.026	.028
1,000	.004	.003	.004	51,500	.123	.027	.029
3,000	.006	.004	.004	52,500	.132	.028	.030
7,000	.007	.004	.004	53,500	.148	.030	.031
9,000	.007	.004	.006	54,500	.168	.032	.034
13,000	.009	.004	.006	56,500	⚠	.035	.037
19,000	.011	.006	.006	58,500		.040	.041
23,000	.012	.006	.007	62,500		.048	.048
31,000	.016	.008	.010	66,500		.059	.056
33,000	.030	.009	.010	70,500		.068	.068
33,500	.034	.010	.015	72,500		.075	.074
34,000	.035	.011	.015	74,500		.080	.080
35,500	.036	.011	.015	78,500		.096	.095
37,500	.043	.011	.015	80,500		.105	.102
39,500	.045	.012	.015	82,500		.114	.111
41,500	.056	.015	.017	84,500		.123	.119
43,500	.064	.017	.018	86,500		.133	.128
45,500	.076	.018	.022	88,500		.149	.139
47,000	.085	.019	.022	90,500		.165	.149
48,500	.099	.021	.026	92,500		.192	.162
49,500	.105	.024	.026	94,500		.199	.176

⚠ STARTER FLAW LENGTH

⚠ CRACK STOP-DRILLED

TABLE 2 - GROWTH BEHAVIOR OF *CORNER* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = *18* ksi, R = +0.1)

SPECIMEN NO. *A-CA-2*, HOLE #1 *Neat-F.t with Load Transfer,* $\frac{T_t}{T_o} = 1.03$

THICKNESS (INCH) *0.4503*, HOLE #2 *Neat-F.t,* $T_o/\sigma_{net} = 0$

WIDTH (INCH) *4.00*, HOLE #3 *Open Hole*

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.003 (1)	.003 (1)	.004 (1)	44000	.179	.039	.066
5000	.003	.003	.007	45500	(2)	.041	.071
10000	.004	.004	.009	47500		.046	.077
15000	.006	.006	.012	49500		.050	.082
20000	.006	.007	.018	51500		.057	.088
25000	.018	.011	.025	53500		.062	.096
27000	.022	.013	.029	55500		.068	.106
29000	.028	.015	.031	57500		.073	.112
31000	.036	.017	.035	59500		.082	.122
33000	.041	.018	.039	61500		.086	.130
35000	.049	.020	.043	63500		.093	.140
37000	.058	.026	.048	65500		.101	.150
38500	.068	.028	.052	67500		.108	.161
39500	.074	.029	.054	69500		.118	.175
40500	.085	.030	.055	71500		.129	.188
41500	.101	.032	.058	73500		.140	.204
42000	.112	.034	.059	75500		.150	.220
42500	.123	.034	.059	77500		.162	.236
43000	.137	.037	.062	79500		.172	.255
43500	.158	.037	.062				

(1) STARTER FLAW LENGTH

(2) CRACK STOP DRILLED

TABLE 3 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-3

THICKNESS (INCH) 0.4498

WIDTH (INCH) 4.00

HOLE #1 TL #2, δ = .00038", $\frac{\sigma_b}{\sigma_o}$ = .101

HOLE #2 TL #1, δ = 0.0024", $\frac{\sigma_b}{\sigma_o}$ = 0

HOLE #3 TL #2, δ = 0.0038", $\frac{\sigma_b}{\sigma_o}$ = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.048	.038	.056	38000	.073	.168	.112
2000	.048	.045	.057	40000	.076	(2)	.115
4000	.049	.050	.062	44000	.088		.123
6000	.051	.057	.065	48000	.091		.130
8000	.055	.064	.067	52000	.094		.141
12000	.056	.075	.071	56000	.094		.150
16000	.058	.087	.075	60000	.104		.162
18000	.059	.091	.080	64000	.107		.171
20000	.060	.096	.084	68000	.114		.183
22000	.062	.104	.085	72000	.123		.195
24000	.063	.109	.090	76000	.129		.206
26000	.067	.116	.091	80000	.138		.218
28000	.069	.123	.093	84000	.146		.232
30000	.072	.123	.096	88000	.153		.250
32000	.073	.140	.097	92000	.160		.272
34000	.073	.148	.103	94000	.168		.280
36000	.073	.157	.107				

(2) HOLE STOP DRILLED

TABLE 4 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-4,
THICKNESS (INCH) 0.4508,
WIDTH (INCH) 4.00,

HOLE #1 TL #2, δ = 0.0038", $\frac{\sigma_b}{\sigma_o}$ = 0.97
HOLE #2 TL #1, δ = 0.0024", $\frac{\sigma_b}{\sigma_o}$ = 0
HOLE #3 TL #2, δ = 0.0038", $\frac{\sigma_b}{\sigma_o}$ = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.037	.025	.043	79900		.054	058
2000	.043	.025	.045			②	②
4000	.046	.025	.045				
6000	.048	.025	.047				
8000	.056	.025	.047				
10000	.060	.026	.048				
12000	.062	.026	.048				
14000	.064	.027	.048				
20000	.073	.028	.048				
24000	.078	.029	.048				
28000	.086	.031	.048				
32000	.095	.033	.049				
35000	.095	.035	.049				
40000	.111	.038	.052				
43000	.124	.041	.052				
46000	.136	.045	.053				
50000	.150	.049	.054				
54000	.168	.054	.054				
58000	①	.054	.056				
65000		.054	.058				
70000		.054	.058				

① HOLE STOP DRILLED

② TEST DISCONTINUED WHEN FAILURE OCCURRED @ HOLE #1.

TABLE 5 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T351 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 19 ksi, R = +0.1)

SPECIMEN NO. A-CA-5, HOLE #1 TL #3, δ = 0.0060", σ_b/σ_a = 0

THICKNESS (INCH) 0.512, HOLE #2 5% C.W. open

WIDTH (INCH) 4.00, HOLE #3 5% C.W. open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.054	.054	.055	125000	.086	.059	.077
3000	.054	.056	.055	135000	.090	.059	.080
7000	.054	.058	.055	145000	.096	.059	.081
22000	.055	.058	.055	155000	.102	.059	.083
34000	.005	.058	.057	165000	.108	.059	.083
35000	.056	.058	.057	175000	.112	.059	.084
37000	.056	.058	.059	185000	.120	.059	.085
41000	.056	.058	.062	195000	.130	.059	.087
44000	.059	.058	.062	200000	.133	.059	.087
52000	.062	.058	.065	205000	.138	.059	.087
59000	.065	.059	.067	210000	.142	.059	.088
63000	.065	.059	.068	215000	.149	.059	.088
67000	.066	.059	.069	220000	.153	.059	.090
73000	.068	.059	.071	225000	.162	.059	.090
76000	.069	.059	.071	230000	.168	.059	.090
91000	.075	.059	.072	290000	⚠	.059	.097
96000	.076	.059	.073	360000		.059	.104
101000	.077	.059	.075	370000		.059	.105
115000	.082	.059	.076				

⚠ CRACK STOP - DRILLED

TABLE 6 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-6,
THICKNESS (INCH) 0.4490,
WIDTH (INCH) 4.00,

HOLE #1 TL #3, δ = 0.0060", σ_b/σ_t = 0
HOLE #2 5% c w open
HOLE #3 2% c.w open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.055	.054	.052	80000	.091	.055	.063
5000	.056	.054	.052	85000	.095	.055	.064
10000	.057	.054	.053	90000	.099	.055	.064
15000	.059	.054	.053	95000	.103	.055	.065
20000	.063	.054	.056	100000	.109	.055	.066
25000	.065	.054	.057	105000	.113	.055	.067
30000	.067	.054	.057	110000	.120	.055	.067
35000	.067	.054	.057	115000	.127	.055	.068
40000	.068	.054	.057	120000	.133	.055	.068
45000	.071	.054	.057	125000	.142	.055	.069
50000	.074	.054	.057	130000	.150	.055	.069
55000	.076	.054	.057	135000	.161	.055	.069
60000	.078	.055	.057	140000	.175	.055	.071
65000	.081	.055	.057	150000	⚠1	.055	.072
70000	.085	.055	.057	130000		.055	.075
75000	.088	.055	.062	190000		.055	.075

⚠1 CRACK STOP-DRILLED

TABLE 7 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-7,
THICKNESS (INCH) 0.4511,
WIDTH (INCH) 4.00,

HOLE #1 2% C.W. - Load Transfer, $\sigma_t/\sigma_o = 0.98$
HOLE #2 2% C.W - Neat-Fit, $\sigma_t/\sigma_o = 0$
HOLE #3 4% C.W. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.047	.048	.045	140000	.134	.060	.045
5000	.048	.048	.045	150000	.155	.060	.045
10000	.054	.048	.045	160000	.165	.060	.045
15000	.056	.048	.045	180000	(1)	.060	.045
20000	.057	.050	.045	270000	(2)	.060	.045
25000	.059	.050	.045				
35000	.062	.053	.046				
45000	.071	.054	.045				
55000	.075	.054	.045				
65000	.078	.055	.045				
75000	.081	.056	.045				
85000	.093	.057	.045				
90000	.097	.057	.045				
95000	.102	.058	.045				
100000	.105	.058	.045				
105000	.109	.059	.045				
110000	.113	.059	.045				
115000	.116	.059	.045				
125000	.123	.060	.045				
135000	.130	.060	.045				

(1) HOLE #1 STOP DRILLED
(2) FAILURE @ HOLE #1

TABLE 8 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-8, HOLE #1 2% C.W. - Load Transfer, $\sigma_b/\sigma_o = 1.08$

THICKNESS (INCH) 0.4503, HOLE #2 2% C.W. - Neat-Fit, $\sigma_b/\sigma_o = 0$

WIDTH (INCH) 4.00, HOLE #3 4% C.W. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.040	.056	.039	225000	.114	.081	.056
2000	.046	.056	.039	245000	.118	.084	.056
4000	.050	.057	.044	265000	.118	.086	.056
10000	.058	.058	.045	275000	.119	.088	.056
14000	.062	.059	.045	295000	.120	.091	.058
22000	.064	.061	.048	305000	.123	.092	.061
26000	.066	.061	.049	325000	.127	.094	.062
30000	.067	.062	.049	345000	.128	.096	.065
40000	.071	.063	.050	355000	.130	.097	.065
45000	.074	.064	.050	375000	.132	.100	.065
50000	.076	.064	.050	395000	.133	.103	.065
85000	.081	.066	.052	415000	.134	.106	.065
105000	.087	.067	.053	435000	.134	.109	.065
115000	.095	.067	.053	455000	.134	.111	.065
145000	.096	.072	.056	475000	.137	.113	.067
165000	.097	.073	.056	495000	.142	.115	.067
175000	.106	.074	.056	515000	.152	.120	.067
185000	.110	.074	.056	526000	⚠		
195000	.113	.076	.056				

⚠ FAILURE

TABLE 9 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-P0-3,
THICKNESS (INCH) 0.4530,
WIDTH (INCH) 4.00,

HOLE #1 TL #2, δ = .0038", σ_b/σ_0 = 0
HOLE #2 TL #2, δ = .0038", σ_b/σ_0 = 0
HOLE #3 TL #3, δ = 0.0060", σ_b/σ_0 = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.056	.054	.043	32000	.076		.084
2000	.057	.060	.047	34000	.077		.087
4000	.057	.069	.050	38000	.080		.092
6000	.059	.081	.054	44000	.084		.102
8000	.064	.093	.056	50000	.087		.109
10000	.065	.103	.056	56000	.093		.123
12000	.065	.115	.058	60000	.099		.128
14000	.066	.125	.060	64000	.100		.137
16000	.067	.135	.064	68000	.106		.144
18000	.068	.144	.067	72000	.111		.153
20000	.069	.150	.071	76000	.118		.160
22000	.071	.159	.072	80000	.122		.167
24000	.072	.166	.075	84000	.130		.177
26000	.073	.172	.080	88000	.136		.184
28000	.074	.183	.081	92000	.142		.194
30000	.075	⚠	.082	95310	.151		.205

⚠ STOP DRILLED

TABLE 10 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-1X, HOLE #1 4% C.W. – open

THICKNESS (INCH) 0.4485, HOLE #2 5% C.W. – open

WIDTH (INCH) 4.010, HOLE #3 Only Two Test Holes

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.059	.046					
4000	.064	.046					
13000	.067	.046					
29000	.071	.047					
48000	.075	.048					
66000	.077	.050					
87000	.085	.052					
111000	.093	.053					
146900	.099	.054					
185000	.108	.056					
229000	.124	.058					
300000	.183	.059					
335000	.300	.060					
350000	.430	.060					
367200	FAILURE	.062					

ONLY TWO HOLES

1.2 2219-T851 Aluminum - Thru Cracks

TABLE II - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 28 ksi, R = +0.1)

SPECIMEN NO. A-CA-9,
THICKNESS (INCH) 0.4512,
WIDTH (INCH) 6.00,

HOLE #1 Neat-Fit with Load Transfer, $\sigma_b/\sigma_o = 1.01$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.0061	.0080	.0067				
750	.0102	.0158	.0181				
1000	.0237	.0305	.0294				
1250	.0362	.0588	.0362				
1400	.0497	.0723	.0486				
1600	.0633	.0859	.0672				
1800	.0768	.1141	.0825				
2000	.0938	.1446	.0961				
2200	.1401	.1955	.1288				
2300	.1605	.2204	.1424				
2400	.1774	.2441	.1526				
2500	.1932	.2723	.1695				
2600	.2204	.2995	.1865				
2700	.2622	.3311	.1989				
2800	.2893	.3616	.2124				
2900	.3367	.3989	.2373				
3000	.3819	.4452	.2452				
3100	.4351	.4882	.2644				
3200	.4859	.5469	.2859				
3300	.5616	.5966	.3006				
3400	.6656	.6644	.3130				

TABLE 12 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 24 ksi, R = +0.1)

SPECIMEN NO. A-CA-10,
THICKNESS (INCH) 0.4508,
WIDTH (INCH) 6.00,

HOLE #1 Neat-Fit with Load Transfer, σ_b/σ_s = 0.96
HOLE #2 Neat-Fit, σ_b/σ_s = 0
HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.0034	.0079	.0090	6800		.5379	.6328
200	.0079	.0136	.0147				
400	.0124	.0192	.0203				
600	.0170	.0226	.0226				
1000	.0283	.0316	.0316				
1300	.0407	.0362	.0396				
1600	.0588	.0531	.0486				
1900	.0768	.0723	.0662				
2200	.0983	.0791	.0723				
2500	.1209	.0927	.0927				
2800	.1446	.1096	.1141				
3100	.1785	.1311	.1356				
3400	.2113	.1684	.1729				
3700	.2576	.1808	.2023				
4000	.2983	.2034	.2283				
4400	.3480	.2384	.2633				
4800	.3944	.2769	.3108				
5200	.4610	.3164	.3661				
5600	.5503	.3537	.4102				
6000	.6565	.4023	.4712				
6400	.8147	.4554	.5368				

TABLE 13 - GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = *18* ksi, R = +0.1)

SPECIMEN NO. *A-CA-12*,
THICKNESS (INCH) *0.4484*,
WIDTH (INCH) *6.00*,

HOLE #1 *TL #2, δ = 0.0038", σ_b/σ_o = 1.13*
HOLE #2 *TL #1, δ = 0.0034", σ_b/σ_o = 0*
HOLE #3 *TL #2, δ = 0.0038", σ_b/σ_o = 0*

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.004	.005	.004				
20,000	.004	.006	.004				
49,000	.004	.008	004				
56,000	.004	.008	.006				
62,000	.005	.008	.006				
73,000	.005	.009	.006				
↓	↓	↓	↓				
255,000	.005	.009	.006				

TABLE 14 - GROWTH BEHAVIOR OF 7 THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-13 ,
THICKNESS (INCH) 0.4519 ,
WIDTH (INCH) 4.00 ,

HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0
HOLE #2 2% C.W - open
HOLE #3 5% C.W - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.006	.005	.006	77000	.006		.007
25000	.006	.053	.006	82000	.006		.007
26000	.006	.056	.006	87000	.012		.007
28000	.006	.060	.006	88540	.155 (53) (2)		.007
30000	.006	.064	.006	90000	.278 (.65)		.007
32000	.006	.067	.006	92000	(1)		.007
34000	.006	.072	.006	95500			.007
36000	.006	.078	.007	97000			.007
38000	.006	.084	.007	98000			.007
40000	.006	.090	.007	99000			.007
42000	.006	.094	.007	100000			.007
47000	.006	.113	.007				
52000	.006	.134	.007				
57000	.006	.181	.007				
62000	.006	.275	.007				
67000	.006	.464	.007				
72000	.006	(1)	.007				

(1) CRACK STOP-DRILLED & TAPER-LOK INSTALLED
(2) CRACK LENGTH AS MEASURED ON REAR SIDE OF SPECIMEN

TABLE 15 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-14, HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0

THICKNESS (INCH) 0.4528, HOLE #2 2% C.W. — open

WIDTH (INCH) 4.00, HOLE #3 5% C.W. — open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.004	.003 (2)	.006	76300	.015	.124	.006
1000	.004	.003 (.02)	.006	76600	.015	.157 (.60)	.006
2000	.004	.006	.006	90000	.017	(1)	.006
3000	.004	.006	.006	92000	.017		.006
4000	.004	.006	.006	92680	.018		.006
5500	.004	.006	.006				
20000	.004	.006	.006				
28500	.004	.006 (.06)	.006				
45000	.004	.006 (.11)	.006				
50000	.004	.006	.006				
51500	.009	.006	.006				
54500	.009	.006 (.16)	.006				
61000	.010	.006 (.23)	.006				
64000	.011	.006	.006				
68000	.012	.006 (.33)	.006				
73000	.012	.006 (.44)	.006				
75000	.012	.041 (.50)	.006				
75200	.012	.050	.006				
75700	.012	.084	.006				
76000	.015	.106	.006				

(1) CRACK STOP-DRILLED & TAPER-LOKED

(2) CRACK LENGTH AS MEASURED ON REAR SIDE OF SPECIMEN

TABLE 16 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-15,
THICKNESS (INCH) 0.4518,
WIDTH (INCH) 4.00,

HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0
HOLE #2 2% CW - open
HOLE #3 5% CW - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.034	.057	.067				
500	.034	.065	.067				
1000	.034	.068	.068				
1500	.035	.071	.071				
2500	.036	.078	.073				
3500	.036	.085	.073				
4500	.067	.090	.073				
5500	.087	.094	.073				
6500	.110	.108	.073				
7500	.138	.114	.073				
8000	.150	.114	.073				
8500	.166	.138	.073				
9000	.180	.141	.073				
9500	.193	.152	.073				
10000	.213	.168	.073				
80000	⚠1	⚠1	.073				

⚠1 CRACK STOP-DRILLED

TABLE 17 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 21 ksi, R = +0.1)

SPECIMEN NO. A-CA-16, HOLE #1 TL #1, δ = .0024", σ_b/σ_a = 0

THICKNESS (INCH) 0.4514, HOLE #2 TL #2, δ = .0038", σ_b/σ_a = 0

WIDTH (INCH) 3.99, HOLE #3 TL #3, δ = .0060", σ_b/σ_a = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.035	.036	.026	6300	.412	.331	.322
300	.054	.051	.036	6800	.471	.356	.362
600	.067	.064	.045	7300	.533	.383	.403
900	.078	.0	.051	7800	.627	.408	.454
1200	.088	.085	.060				
1500	.099	.095	.068				
1800	.114	.107	.077				
2100	.129	.119	.089				
2400	.146	.133	.103				
2700	.160	.148	.116				
3000	.175	.164	.130				
3300	.195	.181	.144				
3600	.217	.195	.157				
3900	.236	.210	.174				
4200	.257	.224	.190				
4500	.278	.237	.207				
4800	.296	.252	.223				
5300	.321	.277	.251				
5800	.374	.303	.284				

TABLE 18 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-17, HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0

THICKNESS (INCH) 0.4528, HOLE #2 2% C.W. – Open

WIDTH (INCH) 6.00, HOLE #3 5% C.W. – open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.103	.155	.149	8500	.349	.390	.149
500	.111	.158	.149	9000	.371	.412	.149
1000	.120	.167	.149	9500	.393	.441	.149
1500	.132	.169	.149	10000	.426	.472	149
2000	.143	.177	.149	10500	.455	.498	.149
2500	.151	.186	.149	11000	.485	.528	.149
3000	.164	.196	.149	11500	.522	.563	.149
3500	.171	.204	.149	16500	△1	△1	.149
4000	.190	.213	.149	46500			.151
4500	.205	.225	.149				
5000	.221	.239	.149				
5500	.237	.258	.149				
6000	.250	.276	.149				
6500	.268	.291	.149				
7000	.287	.312	.149				
7500	.306	.337	.149				
8000	.325	.361	.149				

△1 CRACK STOP-DRILLED

TABLE 19 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-18, HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0

THICKNESS (INCH) 0.4523, HOLE #2 2% C.W. - open

WIDTH (INCH) 6.00, HOLE #3 5% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.104	.146	.144	9500	.476	.179	.148
500	.113	.146	.144	10000	.504	.185	.148
900	.129	.146	.144	10500	.536	.190	.148
1500	.147	.149	.144	11000	⚠1	.198	.148
2000	.162	.151	.144	12000		.213	.148
2500	.179	.152	.146	13000		.226	.148
3000	.194	.153	.146	14000		.245	.148
3500	.206	.155	.146	15000		.274	.148
4000	.232	.156	.146	16000		.301	.148
4500	.246	.157	.146	17000		345	.150
5000	.260	.159	1146	18000		.381	.150
5500	.280	.162	.146	19000		.426	.150
6000	.304	.166	.148	20000		.473	.150
6500	.329	.167	.148	21000		.540	.150
7000	.346	.168	.148	26000		⚠1	.150
7500	.367	.169	.148	56000			.150
8000	.391	.170	.148				
8500	.416	.174	.148				
9000	.439	.178	.148				

⚠1 CRACK STOP-DRILLED

TABLE 20 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-19, HOLE #1 2% c.w. - Load Transfer, σ_b/σ_o = 1.02

THICKNESS (INCH) 0.4511, HOLE #2 2% c.w. - Neat-Fit

WIDTH (INCH) 4.00, HOLE #3 4% c.w. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.057	.050	.056	9000	(1)	.113	.063
500	.065	.055	.057	9500		.122	.063
1000	.069	.059	.058	10000		.132	.063
1500	.073	.063	.060	10500		.144	.063
2000	.076	.065	.062	11000		.158	.063
2500	.081	.066	.062	11500		.174	.063
3000	.086	.067	.062	12000		.192	.063
3500	.092	.069	.062	12500		(1)	.063
4000	.100	.072	.062	15000			.063
4500	.108	.074	.062	20000			.063
5000	.114	.077	.063	25000			.063
5500	.122	.080	.063	30000			.063
6000	.130	.082	.063	35000			.063
6500	.141	.085	.063	37200			.063
7000	.155	.091	.063				
7500	.170	.096	.063				
8000	.189	.102	.063				
8500	.222	.108	.063				

(1) CRACK STOP-DRILLED

TABLE 21 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-20, HOLE #1 2% c.w. - Load Transfer, σ_b/σ_o = 1.06

THICKNESS (INCH) 0.4508, HOLE #2 2% c.w. - Neat - Fit

WIDTH (INCH) 4.00, HOLE #3 4% c.w. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.041	.041	.073	10000	.196	.094	.073
500	.043	.041	.073	10500	.212	.102	.073
1000	.053	.044	.073	11000	.230	.109	.073
1500	.058	.044	.073	11500	(1)	.119	.073
2000	.065	.044	.073	12000		.130	.073
2500	.069	.045	.073	12500		.143	.073
3000	.074	.047	.073	13000		.157	.073
3500	.080	.048	.073	13500		.186	.073
4000	.086	.050	.073	14000		.205	.073
4500	.095	.053	.073	15000		(1)	.073
5000	.106	.055	.073	35000			.075
5500	.111	.056	.073	52000			.077
6000	.116	.056	.073	71200			.077
6500	.122	.059	.073				
7000	.128	.063	.073				
7500	.137	.066	.073				
8000	.148	.069	.073				
8500	.158	.073	.073				
9000	.169	.081	.073				
9500	.183	.085	.073				

(1) CRACK STOP-DRILLED

TABLE 22 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-21, HOLE #1 2% c.w - Load Transfer, σ_b/σ_o = 1.02

THICKNESS (INCH) 0.4528, HOLE #2 2% c.w - Neat - Fit

WIDTH (INCH) 6.00, HOLE #3 4% c.w - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.136	.157	.125	10000	.338	.591	.134
500	.144	.170	.131	10500	.372	⚠1	.134
1000	.146	.176	.132	11000	.393		.134
1500	.155	.185	.132	11500	.422		.134
2000	.158	.192	.132	12000	.449		.134
2500	.162	.202	.133	12500	.486		.134
3000	.167	.215	.133	13000	.519		.134
3500	.171	.226	.133	13500	.561		.134
4000	.174	.237	.133	18500	⚠1		.137
4500	.181	.267	.133	23500			.140
5000	.189	.282	.134	28500			.142
5500	.196	.304	.134	38500			.144
6000	.207	.327	.134	53500			.146
6500	.214	.348	.134				
7000	.226	.374	.134				
7500	.249	.407	.134				
8000	.260	.439	.134				
8500	.278	.473	.134				
9000	.295	.505	.134				
9500	.319	.548	.134				

⚠1 CRACK STOP-DRILLED

TABLE 23 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-22, HOLE #1 2% C.W - Load Transfer, σ_b/σ_o = 1.05

THICKNESS (INCH) .4532, HOLE #2 2% C.W - Neat - Fit

WIDTH (INCH) 6.00, HOLE #3 4% C.W - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.093	.125	.168	10500	.221	.250	.183
500	.104	.127	.168	11000	.243	.264	.184
1000	.109	.133	.168	11500	.260	.276	.184
1500	.113	.136	.169	12000	.277	.291	.185
2000	.115	.137	.169	12500	.295	.308	.185
2500	.121	.141	.169	13000	.317	.326	.186
3000	.124	.146	.169	13500	.337	.344	.188
3500	.127	.149	.172	14000	.358	.362	.188
4000	.128	.152	.175	14500	.382	.382	.188
4500	.131	.155	.176	15000	.401	.405	.188
5000	.136	.157	.176	15500	.424	.427	.190
5500	.140	.161	.176	16000	.448	.452	.190
6000	.148	.166	.176	16500	.477	.478	.190
6500	.157	.169	.176	17000	.510	.504	.193
7000	.160	.178	.177	17500	.542	.531	.194
7500	.168	.186	.179	18000	.579	.558	.195
8000	.176	.194	.179	23000	(1)	(1)	.213
8500	.183	.202	.180	26000			.248
9000	.192	.212	.180	28000			.291
9500	.203	.225	.181	28500			.304
10000	.216	.237	.181	29000			.319

(1) CRACK STOP-DRILLED

(CONT.)

TABLE 23 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (CONTINUED) (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-22,
THICKNESS (INCH) 0.4532,
WIDTH (INCH) 6.00,

HOLE #1 2% C.W. - Load Transfer, σ_b/σ_a = 1.05
HOLE #2 2% C.W. - Neat - Fit
HOLE #3 4% C.W. - Open

(CONT.)

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
29500			.335				
30000			.348				
30500			.368				
31000			.389				
31500			.405				
32000			.426				
32500			.450				
33000			.472				
33500			.496				
34000			.524				
34500			.553				
35000			.587				

TABLE 24 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-P0-7,
THICKNESS (INCH) 0.4510,
WIDTH (INCH) 4.00,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #2 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 TL #3, δ = 0.0060", σ_b/σ_o = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.011	.006	.002	385000	.027	.006	.002
5000				405000	.038		
25000				425000	.056		
45000				435000	.067		
65000				445000	.075		
85000				455000	.092		
105000				467000	.116		
125000				472000	.133		
145000				475000	.142		
165000				478000	.151		
185000				481000	.160		
205200				484000	.170		
225000				504000	⚠		
245000				524000		.006	
265000				544000		.700	.002
285000							
305000	.011						
325000	.012						
345000	.012						
365000	.018	.006	.002				

⚠ CRACK STOP-DRILLED

TABLE 25 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-P0-8,
THICKNESS (INCH) 0.4520,
WIDTH (INCH) 4.00,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #2 TL #3, δ = 0.0060", σ_b/σ_o = 0
HOLE #3 Only Two Test Holes

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.110	.093		38000	.380	.230	
1000	.113	.093		39000	.393	.236	
2500	.118	.097		40000	.408	.239	
5500	.132	.105		41000	.427	.249	
8500	.146	.113		42000	.441	.254	
11500	.157	.117		43000	.459	.261	
14500	.168	.126		44000	.479	.272	
17500	.184	.134		45000	.497	.276	
20500	.204	.142		46000	.515	.284	
22000	.216	.149		47000	.545	.292	
23500	.227	.155		48000	.571	.301	
25000	.239	.160		49000	.598	.308	
26500	.253	.167		50000	.641	.319	
28000	.269	.172		51000	⚠	.330	
29500	.283	.177		52000		.338	
31000	.295	.186		53000		.351	
32500	.306	.195		54000		.355	
34000	.329	.205		55000		.365	
35500	.347	.214		56000		.373	
37000	.366	.224		57000		.388	
				58000		.401	
				59000		.417	

⚠ CRACK STOP-DRILLED

(CONT.)

TABLE 25 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)
(CONTINUED)

SPECIMEN NO. A-PO-8 (CONTI),
THICKNESS (INCH) 0.4520 ,
WIDTH (INCH) 4.00 ,

HOLE #1 TL#2, δ = 0.0038", σ_b/σ_o = 0
HOLE #2 TL#3, δ = 0.0060", σ_b/σ_o = 0
HOLE #3 Only Two Test Holes

(CONT.)

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
60000		.431					
61000		.445					
62000		.462					
63000		.477					
64000		.496					
65000		.513					
66000		.529					
67000		.547					
68000		.565					

TABLE 26.. GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-2X, HOLE #1 Open Hole

THICKNESS (INCH) 0.451T; HOLE #2 Neat-Fit Hole, $\sigma_b/\sigma_o = 0$

WIDTH (INCH) 4.008, HOLE #3 Only Two Test Holes

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.006	.006					
1500	.012	.011					
3000	.019	.021					
4500	.040	.028					
6000	.072	.038					
7500	.092	.058					
9000	.112	.077					
11000	.140	.090					
13000	.175	.103					
21000	.367	.258					
22500	.419	.297					

TABLE 27 - GROWTH BEHAV'OR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-3X,
THICKNESS (INCH) 0.4502,
WIDTH (INCH) 4.008,

HOLE #1 Neat - Fit with Load Transfer, σ_b/σ_o = 0.99
HOLE #2 only one Test Hole
HOLE #3 "

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.004			40000	.273		
2000	.011			41000	.309		
4000	.017			42000	.325		
6000	.028			43000	.345		
8000	.038						
10000	.048						
12000	.053						
14000	.071						
16000	.083						
18000	.096						
19000	.103						
22000	.124						
24000	.142						
26000	.157						
28000	.176						
30000	.190						
32000	.207						
34000	.226						
36000	.270						
38000	.293						

TABLE 28 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-SA-4X,
THICKNESS (INCH) 0.4494,
WIDTH (INCH) 4.008,

HOLE #1 TL#1, δ = 0.0024", σ_b/σ_a = 0
HOLE #2 TL#1, δ = 0.0024", σ_b/σ_a = 0
HOLE #3 ONLY TWO HOLES

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.011	.013		70000	.368	.049	
1000	.016	.016		72000	.391		
3000	.021	.016		74000		.060	
6000	.031	.018		78000		.066	
9000	.045	.018		82000		.073	
12000	.045	.018		85850		.081	(1)
15000	.063	.019					
20000	.075	.019					
25000	.093	.020					
33700	.124	.021					
40000	.152	.022					
45000	.176	.024					
49000	.198	.026					
53000	.222	.028					
57000	.251	.030					
60000	.274	.036					
63000	.299	.038					
66000	.328	—					
68000	.347	—					

(1) TEST DISCONTINUED

TABLE 29 - GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = *18* ksi, R = +0.1)

SPECIMEN NO. *A-CA-5X*, HOLE #1 *5% C.W. - open*

THICKNESS (INCH) *0.4484*, HOLE #2 *5% C.W. - open*

WIDTH (INCH) *4.010*, HOLE #3 *Only Two Test Holes*

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.159	.141		85500	.483	.151	
3000	.170	.143		86200	.500	″	
6000	.174	.144		86900	.521	″	
12000	.177	.144		87600	.541	.151	⚠
22000	.183	.146					
33000	.188	.148					
43000	.199	.150					
50000	.203	.151					
60000	.215	″					
70000	.2	″					
75000	.291	″					
77000	.315	″					
78000	.328	″					
79000	.346	″					
80000	.361	″					
81000	.377	″					
82000	.400	″					
82700	.414	″					
83400	.432	″					
84100	.449	″					
84800	.466	.151					

⚠ TEST DISCONTINUED

TABLE 30 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-6X,
THICKNESS (INCH) 0.4506,
WIDTH (INCH) 4.002,

HOLE #1 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #2 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 TL #3, δ = 0.0060", σ_b/σ_o = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.055	.056	.056				
4000	.057	.057	.056				
8000	.080	.067	.058				
12000	.094	.076	.065				
16000	.110	.083	.068				
20000	.119	.092	.073				
24000	.129	.107	.078				
30000	.150	.122	.087				
36000	.175	.146	.093				
42000	.207	.168	.103				
48000	.249	.189	.111				
54000	.326	.215	.117				
60000	.470	.239	.132				
64000	.653	.258	.139				
68000	—	.273	.150				
68570	⚠	.276	.150				

⚠ FAILURE HOLE #1

TABLE 31 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 18 ksi, R = +0.1)

SPECIMEN NO. A-CA-7X,
THICKNESS (INCH) 0.4496,
WIDTH (INCH) 4.002,

HOLE #1 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #2 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 TL #3, δ = 0.0060", σ_b/σ_o = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.144	.149	.147				
1000	.168	.162	.147				
2000	.181	.170	.149				
3000	.193	.181	.151				
4000	.207	.191	.156				
5000	.220	.202	.163				
6000	.232	.209	.171				
8000	.264	.224	.189				
10000	.300	.247	.197				
12000	.336	.274	.210				
14000	.381	.302	.224				
16000	.434	.328	.237				
18000	.496	.366	.258				
20000	.583	.406	.273				
22000	.697	.461	.295				
24000	———	.519	.316				
26000	———	.586	.339				
26450	⚠1	.602	.351				

⚠1 FAILURE @ HOLE #1

1.3 6Al-4V Beta Annealed Titanium - Corner Cracks

TABLE 32 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-1,
THICKNESS (INCH) 0.379,
WIDTH (INCH) 4.000,

HOLE #1 Neat-Fit - Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.003	.003	.004	32600	△	003	.010
1000	.003	.003	.004	34600		.003	.011
4000	.003	.003	.004	39600		.003	.016
9000	.003	.003	.004	44600		.006	.022
14000	.011	.003	.004	49600		.011	.044
19000	.034	.003	.006	51600		.013	.058
20000	.036	.003	.006	53600		.015	.075
22000	.056	.003	.006	55600		.016	.095
23000	.066	.003	.006	56600		.017	.104
24000	.075	.003	.006	57600		.019	.114
25000	.086	.003	.007	58600		.019	.137
26000	.101	.003	.007	59600		.020	.153
27000	.116	.003	.007	60600		.020	.174
27600	.131	.003	.007	61400		.022	.186
28200	.140	.003	.008	61950	FAILED	.022	.197
28800	.149	.003	.008				
29400	.166	.003	.008				
30000	.177	.003	.009				
30600	.199	.003	.010				

△ STOP-DRILLED

TABLE 33 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-2,
THICKNESS (INCH) 0.377,
WIDTH (INCH) 4.000,

HOLE #1 Neat-Fit - Load Transfer, σ_b/σ_a = 1.01
HOLE #2 Neat-Fit, σ_b/σ_a = 0
HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.001	.001	.003	49360			.016
5000	.001	.001		52000			.020
10000	.001	.002		54320			.039
15000	.001	.012		55000			.055
20000	.011	.020		56000			.076
25000	.026	.029		56500			.085
30000	.146	.044		57000			.093
30500	.170	.047		57500			.100
31500	①	.056		58000			.108
32500		.067		58500			.118
33500		.075		59000			.127
34500		.081		59500			.132
36000		.090		60000			.146
37500		.103		60500			.170
39000		.125		61000			.187
40000		.140					
41000		.152					
42000		.172					
47000		①	.003				

① CRACK STOP-DRILLED

TABLE 34 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-3,
THICKNESS (INCH) 0.3751,
WIDTH (INCH) 4.003,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 0.99
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0042", σ_b/σ_o = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.046	.050	.037	82000	.124		.104
1000	.046	.053	.037	87000	.146		.114
2000	.046	.056	.037	90000	.148		.121
4000	.046	.058	.037	91670	.157	FAILED	.127
8000	.046	.068	.037				
12000	.046	.075	.037				
17000	.046	.083	.039				
22000	.052	.092	.039				
27000	.059	.108	.046				
32000	.065	.132	.048				
35000	.068	.146	.049				
38000	.072	.162	.056				
41000	.077	.188	.057				
46000	.082	⚠	.061				
51000	.086		.064				
58000	.093		.072				
65000	.095		.084				
72000	.102		.101				
77000	.113		.101				

⚠ CRACK STOP-DRILLED

TABLE 35 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-cA-4,
THICKNESS (INCH) 0.3764,
WIDTH (INCH) 4.00,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_a = 1.01
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_a = 0
HOLE #3 TL #2, δ = 0.0042", σ_b/σ_a = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.059	.049	.054	63000	.180	.149	
1000	.060	.049	.054	67000	.204	.156	
2000	.060	.049	.054	71000	.226	.162	
5000	.060	.053	.054	75000	.251	.176	
8000	.062	.057	.062				
9000	.065	.060	.063				
11000	.067	.063	.065				
15000	.077	.066	.065				
19000	.091	.072	.077				
23000	.092	.078	.087				
27000	.100	.083	.101				
31000	.106	.086	.112				
35000	.114	.091	.124				
39000	.121	.095	.139				
43000	.127	.102	.151				
47000	.138	.112	.168				
51000	.146	.123	.198				
55000	.156	.133	(1)				
59000	.168	.141					

(1) END OF CRACK PUNCHED

TABLE 36- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-5,
THICKNESS (INCH) 0.374,
WIDTH (INCH) 4.007,

HOLE #1 TL #3, δ = 0.0050", σ_{br}/σ_o = 1.04
HOLE #2 TL #3, δ = 0.0050", σ_{br}/σ_o = 0
HOLE #3 4% C.W. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.060	.035	.040	34500	.141	.037	
1000	.060	.036	.045	35500	.150	.037	
3000	.063	.037	.056	36500	.152	.037	
6000	.063	.037	.071	37500	.157	.037	
6500	.072	.037	.086	38500	.164	.037	
7500	.072	.037	.094	39130	.166	.037	FAILED
8500	.078	.037	.108				
9500	.078	.037	.125				
10500	.078	.037	.139				
11500	.080	.037	.19				
12500	.080	.037	.179				
13500	.083	.037	.202				
14500	.083	.037	.228				
16500	.087	.037	⚠1				
20500	.094	.037					
24500	.099	.037					
28500	.116	.037					
31500	.132	.037					
33500	.139	.037					

⚠1 CRACK STOP-DRILLED

TABLE 37- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-cA-6,
THICKNESS (INCH) 0.3732,
WIDTH (INCH) 4.00,

HOLE #1 TL #3, δ = 0.0050", σ_b/σ_0 = 1.04
HOLE #2 TL #3, δ = 0.0050", σ_b/σ_0 = 0
HOLE #3 4% C.W. – open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.043	.058	.047	40000	.093	.193	
2000	.043	.058	.047	40440	.095	.196	FAILED
6000	.043	.065	.061				
9000	.045	.080	.090				
10000	.045	.081	.101				
11000	.045	.087	.112				
12000	.049	.092	.128				
13000	.049	.094	.143				
14000	.049	.099	.157				
15000	.049	.104	.172				
16000	.050	.108	.192				
17000	.050	.108	.209				
18000	.051	.112	.227				
20000	.059	.116	⚠1				
24000	.069	.127					
28000	.078	.136					
32000	.080	.144					
36000	.091	.170					
38000	.091	.183					

⚠1 CRACK STOP-DRILLED

TABLE 38- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-~,
THICKNESS (INCH) 0.3741,
WIDTH (INCH) 4.001,

HOLE #1 2% c.w. - Load Transfer, σ_b/σ_o = 1.01
HOLE #2 2% c.w. - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% c.w. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.075	.063	.057	9500		.190	.120
2000	.104	.080	.057	10000		.203	.125
2500	.118	.082	.062	10500		.215	.134
2800	.123	.086	.063	11000		.227	.140
3100	.133	.090	.063	11500		.242	.150
3400	.138	.092	.067	12000		.258	.162
3700	.146	.097	.067	12500		.272	.174
4000	.151	.101	.073				
4300	.156	.104	.078				
4600	.159	.109	.080				
4900	.178	.113	.081				
5200	.185	.115	.084				
6000	△1	.134	.085				
6500		.137	.087				
7000		.149	.091				
7500		.156	.093				
8000		.161	.096				
8500		.168	.102				
9000		.180	.108				

△1 CRACK STOP-DRILLED

TABLE 39 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-8,
THICKNESS (INCH) 0.3742,
WIDTH (INCH) 4.001,

HOLE #1 2% c.w - Load Transfer, σ_b/σ_o = 1.03
HOLE #2 2% c.w - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% c.w. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.058	.056	.056	13000		.166	.157
500	.065	.056	.057	14000		.172	.179
1000	.071	.056	.058				
2000	.088	.057	.058				
2800	.101	.060	.058				
3600	.123	.068	.063				
4000	.127	.071	.064				
4500	.134	.074	.065				
5000	.146	.078	.067				
5500	.157	.081	.069				
6000	.179	.084	.076				
6500	.190	.087	.082				
7000	.213	.101	.086				
7500	[1]	.103	.091				
8000		.109	.094				
9000		.119	.101				
10000		.130	.108				
11000		.142	.114				
12000		.155	.134				

[1] CRACK STOP-DRILLED

1.4 6Al-4V Beta Annealed Titanium - Thru Cracks

TABLE 40 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-9, HOLE #1 Neat-Fit - Load Transfer, $\sigma_b/\sigma_o = 1.05$

THICKNESS (INCH) 0.378, HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$

WIDTH (INCH) 5.031, HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.003	.001	.013	7500	.280	.235	.258
1650	.037	.015	.049	7800	.296	.244	.272
2000	.050	.029	.058	8100	.298	.259	.281
2300	.059	.045	.060	8400	.306	.276	.293
2600	.071	.053	.075	8700	.324	.288	.306
2900	.083	.067	.083	9000	.331	.300	.315
3100	.100	.077	.091	9300	.355	.314	.330
3600	.106	.090	.093	9600	.373	.321	.355
3900	.115	.093	.104	9900	.389	.332	.367
4200	.130	.100	.112	10200	.407	.347	.385
4500	.138	.112	.123	10500	.428	.373	.404
4800	.151	.124	.133	10800	.451	.388	.419
5100	.167	.134	.143	11100	.474	.407	.437
5400	.174	.144	.154	11400	.497	.437	.457
5700	.186	.157	.167	11700	.548	.460	.470
6000	.196	.182	.178	12000	.575	.482	.493
6300	.208	.186	.193	12300	.592	.511	.516
6600	.228	.202	.211	12600	.627 (1)	.529	.545
6900	.239	.209	.231				
7200	.254	.232	.246				

(1) DISCONTINUED TESTING

TABLE 41 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-10,
THICKNESS (INCH) 0.377,
WIDTH (INCH) 5.004,

HOLE #1 Neat-Fit-Load Transfer, σ_b/σ_o = 1.03
HOLE #2 Neat-Fit, σ_b/σ_o = 0
HOLE #3 Open Hole

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.002	.008	.020	10000	.344	.269	.333
500	.002	.015	.024	10500	.362	.281	.367
1000	.019	.015	.029	11000	.388	.309	.386
1500	.024	.016	.035	11500	.414	.324	.412
2000	.037	.017	.046	12000	.447	.336	.451
2500	.058	.022	.062				
2800	.064	.026	.073				
3500	.082	.048	.094				
4000	.097	.067	.112				
4500	.112	.085	.129				
5000	.133	.103	.146				
5500	.140	.123	.159				
6000	.168	.138	.170				
6500	.186	.155	.181				
7000	.203	.166	.196				
7500	.216	.177	.215				
8000	.251	.194	.242				
8500	.269	.228	.267				
9000	.293	.239	.291				
9500	.318	.249	.311				

TABLE 42 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-11,
THICKNESS (INCH) 0.376,
WIDTH (INCH) 5.000,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_a = 1.10
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_a = 0
HOLE #3 TL #1, δ = 0.0034", σ_b/σ_a = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.011	.006	.004	135000	.304	.007	.007
3000	.011			136000	.338		
4000	.012			136500	.345 (1)		
5000	.012			142500			
15000	.012			146500			
20000	.012		.004	170500	(2)	.007	.007
50000	.018		.006				
60000	.018						
70000	.019						
80000	.022						
90000	.037						
100000	.043						
110000	.056		.006				
120000	.075	.006	.007				
130000	.138	.007					
132000	.200						
132500	.214						
133000	.245						
134000	.265						
134500	.279	.007	.007				

(1) CRACK STOP-DRILLED
(2) SPECIMEN FAILED IN GRIP

TABLE 43 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-12,
THICKNESS (INCH) 0.378,
WIDTH (INCH) 5.007,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 0.96
HOLE #2 TL #2, δ = 0.0042", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0042", σ_b/σ_o = 0

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.011	.011	.010				
5000	.020						
15000	.022						
20000	.022						
30000	.022						
35000	.024						
45000	.025						
50000	.031						
55000	.043						
60000	.054						
68500	.078						
70000	.088						
70210	.088 ⚠	.011	.010				

⚠ SPECIMEN FAILED IN GRIP AREA

TABLE 44 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-13, HOLE #1 2% C.W. - Load Transfer, σ_b/σ_o = 0.94

THICKNESS (INCH) 0.376, HOLE #2 2% C.W. - Neat-Fit, σ_b/σ_o = 0

WIDTH (INCH) 4.003, HOLE #3 2% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.003	0	.009	10500		.140	.123
500	.009		.013	11000		.157	.134
1500	.018		.024	11500		.162	.143
2500	.039		.029	12000		.185	.155
3000	.050		.034	12500		.211	.168
3500	.065		.037				
4000	.078	0	.040				
4500	.093	.003	.044				
5000	.115	.007	.047				
5500	.127	.022	.052				
6000	.143	.037	.056				
6500	.157	.048	.063				
7000	.186	.063	.072				
7500	⚠1	.072	.078				
8000		.078	.083				
8500		.094	.090				
9000		.101	.097				
9500		.112	.104				
10000		.127	.115				

⚠1 CRACK STOP-DRILLED

TABLE 45- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-14,
THICKNESS (INCH) 0.376,
WIDTH (INCH) 4.005,

HOLE #1 2% C.W. - Load Transfer, σ_b/σ_o = 0.94
HOLE #2 2% C.W. - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.004	.013	.006	11800		.239	.146
500	.007	.015	.011	12300		.254	.152
1500	.011	.022	.013	12800		.271	.162
2500	.013	.027	.015	13300		.296	.171
4500	.083	.039	.026				
5000	.096	.045	.030				
5500	.116	.054	.036				
6000	.144	.065	.037				
6500	.161	.075	.041				
7000	.177	.076	.049				
7500	.205	.095	.054				
8000	⚠1	.114	.066				
8300		.120	.072				
8800		.136	.081				
9300		.150	.088				
9800		.169	.096				
10300		.183	.106				
10800		.200	.116				
11300		.222	.127				

⚠1 CRACK STOP-DRILLED

TABLE 46 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-15,
THICKNESS (INCH) 0.375,
WIDTH (INCH) 4.001,

HOLE #1 2% C.W. - Load Transfer, σ_b/σ_o = 1.02
HOLE #2 2% C.W. - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% C.W. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.056	.064	.011	8400			.155
1000	.078	.081	.019	8900			.164
1500	.095	.096	.019	9400			.183
1800	.104	.109	.026				
2100	.112	.112	.026				
2400	.121	.120	.026				
2700	.128	.127	.027				
3000	.138	.138	.029				
3300	.151	.150	.034				
3600	.168	.150	.039				
3900	.183	.159	.045				
4200	.190	.166	.050				
4500	.216	.177	.058				
5000	⚠1	⚠1	.067				
57[illegible]			.081				
6400			.101				
6900			.113				
7400			.125				
7900			.141				

⚠1 CRACK STOP-DRILLED

TABLE 47- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-16, HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 0.90$

THICKNESS (INCH) 0.375, HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$

WIDTH (INCH) 4.003, HOLE #3 2% c.w. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.037	.050	.059				
1000	.056	.058	.078				
1700	.078	.083	.100				
2100	.091	.097	.108				
2500	.106	.110	.119				
2900	.118	.122	.131				
3300	.140	.134	.146				
3600	.149	.143	.153				
3900	.162	.153	.164				
4200	.186	.166	.174				
4500	.216	.177	.187				

TABLE 48 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-17,
THICKNESS (INCH) 0.378",
WIDTH (INCH) 5.005,

HOLE #1 2% C.W. - Load Transfer, σ_b/σ_o = 1.10
HOLE #2 2% C.W. - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.178	.119	.132	8200	.623	.400	.512
500	.189	.129	.147	8600	.635	.426	.539
1000	.203	.138	.168	9000	.691	.444	.568
1500	.225	.155	.187	9400	.736	.463	.588
1800	.231	.164	.195	9800	.792	.494	.604
2200	.254	.177	.209	10200	.815	.512	.644
2600	.277	.193	.226	10600	.852	.534	.685
3000	.290	.205	.240	11000	.912	.551	.711
3400	.305	.215	.251	11400	.982	.579	.749
3800	.326	.228	.267				
4200	.351	.240	.297				
4600	.388	.258	.318				
5000	.402	.269	.338				
5400	.420	.228	.356				
5800	.445	.311	.367				
6200	.474	.321	.385				
6600	.501	.330	.419				
7000	.536	.339	.435				
7400	.560	.362	.462				
7800	.586	.382	.487				

TABLE 49- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-18,
THICKNESS (INCH) 0.378,
WIDTH (INCH) 5.001,

HOLE #1 2% C.W. - Load Transfer, σ_b/σ_o = 1.05
HOLE #2 2% C.W. - Neat-Fit, σ_b/σ_o = 0
HOLE #3 2% C.W. - Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.177	.136	.158	7600	.571	.474	.476
400	.202	.144	.165	8000	.609	.497	.534 (1)
800	.220	.155	.185	8400	.638	.534	.534
1200	.233	.177	.197	8800	.673	.548	.556
1600	.249	.195	.209	9200	.682	.573	.586
2000	.265	.206	.220				
2400	.292	.224	.234				
2800	.311	.246	.252				
3200	.333	.263	.268				
3600	.353	.277	.286				
4000	.371	.304	.308				
4400	.399	.314	.330				
4800	.427	.325	.335				
5200	.449	.349	.353				
5600	.464	.367	.373				
6000	.486	.396	.394				
6400	.508	.419	.413				
6800	.535	.439	.431				
7200	.556	.455	.451				

(1) CRACK FORKED

TABLE 50 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-19,
THICKNESS (INCH) 0.376,
WIDTH (INCH) 4.005,

HOLE #1 TL #3, δ = 0.0050", σ_b/σ_a = 0
HOLE #2 TL #3, δ = 0.0050", σ_b/σ_a = 0
HOLE #3 4% C.W. — Open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.048	.016	.040	25000	.161	.053	
500	.048	.019	.093	27500	.171	.056	
1500	.048	.020	.112	31000	(1)	.066	
2200	.050	.020	.132	34000		.081	
2600	.053	.021	.141	36000		.112	
3000	.056	.021	.152	36700		.116	
3400	.056	.022	.164	37400		.137	
3800	.058	.025	.176	37800		.142	
4400	.058	.025	(1)	38200		.156	
5500	.065	.026		38600		.166	
6500	.067	.026		39000		.177	
8500	.073	.027					
10500	.077	.031					
12600	.081	.032					
15000	.099	.036					
17000	.114	.038					
18500	.121	.040					
20000	.127	.044					
22500	.137	.046					

(1) CRACK STOP-DRILLED

TABLE 51 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-20, HOLE #1 5% C.W - open

THICKNESS (INCH) 0.376, HOLE #2 5% C.W - open

WIDTH (INCH) 4.007, HOLE #3 4% C.W - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.071	.084	.065				
500	.078	.091	.065				
1000	.083	.095	.065				
2060	.104	.101	.065				
2500	.115	.105	.069				
3020	.129	.109	.071				
3500	.146	.119	.072				
4000	.157	.127	.073				
4500	.170	.138	.074				
5000	.184	.143	.075				
5500	.209	.171	.077				
6500	⚠	⚠	.081				
9500			.146				
10000			.175				

⚠ CRACK STOP-DRILLED

TABLE 52 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-21,
THICKNESS (INCH) 0.377,
WIDTH (INCH) 5.011,

HOLE #1 TL #3, δ = 0.0050", σ_b/σ_o = 0
HOLE #2 TL #3, δ = 0.0050", σ_b/σ_o = 0
HOLE #3 4% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.1602	.1165	.1232	15800	.4257	.3405	.4850
3000	.1960	.1467	.1310	16200	.4514	.3551	.5040
5000	.2162	.1546	.1389	16600	.4738	.3662	.5286
7000	.2430	.1826	.1747	17000	.4838	.3797	.5533
8500	.2733	.2027	.2139	17400	.4928	.3875	.6048
9500	.2867	.2195	.2352	17800	.5040	.3931	.6227
10500	.3024	.2397	.2702	18200	.5398	.4043	.6317
11000	.3091	.2509	.2916	18600	.6432	.4155	.6496
11500	.3170	.2610	.3069	20000	.5667	.4256	.6832
12000	.3270	.2677	.3293	20400	.5936	.4357	.7056
12500	.3382	.2710	.3494	20800	.6138	.4458	.7504
13000	.3483	.2822	.3808	21200	.6306	.4547	.7795 ⚠
13300	.3550	.2878	.3942				
13600	.3584	.2968	.4021				
13900	.3696	.3035	.4099				
14200	.3752	.3058	.4189				
14600	.3853	.3147	.4346				
15000	.3976	.3237	.4480				
15400	.4178	.3282	.4592				

⚠ DISCONTINUED TESTING

TABLE 53- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V BA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-22,
THICKNESS (INCH) 0.378,
WIDTH (INCH) 5.006,

HOLE #1 5% C.W. - open
HOLE #2 5% C.W. - open
HOLE #3 4% C.W. - open

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.1736	.1501	.1523	12500	.3584	.3998	
2000	.1747	.1501	.1747	13000	.3830	.4099	
4000	.1747	.1512	.2152	13500	.4066	.4368	
4500	.1758	.1512	.2285	14000	.4245	.4637	
5000	.1758	.1736	.2498	14500	.4491	.4861	
5500	.1826	.1758	.2632	15000	.4670	.5062	
6000	.1904	.1837	.2867	15500	.4861	.5253	
6500	.1938	.1915	.3091	16000	.5085	.5466	
7000	.2016	.2061	.3270				
7500	.2162	.2173	.3517				
8000	.2318	.2285	.3707				
8500	.2554	.2643	.3976				
9000	.2621	.2710	.4211				
9500	.2766	.2867	.4435				
10000	.2856	.3046	.4659				
10500	.2946	.3147	.4883				
11000	.3181	.3427	△				
11500	.3282	.3574					
12000	.3382	.3786					

△ CRACK STOP-DRILLED

TABLE 54 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-S-3,
THICKNESS (INCH) 0.379,
WIDTH (INCH) 4.01,

HOLE #1 4% c.w - open
HOLE #2 4% c.w. - open
HOLE #3 Only Two Test Holes

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.034	.015		16500	.103		
1000	.039	.029		17000	.112		
1500	.039	.039		17300	.123		
2000	.039	.045		17500	.129		
2500	.040	.059		17700	.131		
2900	.040	.071		17900	.134		
3300	.040	.086		18100	.147		
3500	.040	.093		18300	.152		
3700	.040	.101		18500	.157		
3900	.040	.110		[illegible]	.164		
4100	.040	.115		[illegible]	.170		
4300	.040	.125					
4500	.040	.129					
4700	.040	.138					
4900	.040	.146					
5100	.040	.150					
5300	.040	.158					
5500	.040	.165					
6500	.040	⚠					
11500	.040						

⚠ CRACK STOP-DRILLED

TABLE 55 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-1X,
THICKNESS (INCH) 0.3788,
WIDTH (INCH) 4.008,

HOLE #1 IF #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #2 IF #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 ONLY TWO HOLES

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.013	.011		11700	.022	.274	
2400	.013	.069		12700	.027	.305	
2500	.013	.073		13700	.035	.352	
3000	.017	.076					
3300	|	.080					
3900	|	.089					
4100	|	.105					
4500	|	.114					
4900	|	.125					
5300	|	.132					
5700	|	.140					
6100	|	.149					
6500	|	.158					
6900	|	.168					
7300	|	.178					
7900	|	.192					
8700	|	.198					
9700	017	.222					
10700	.019	.248					

TABLE 56- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO CONSTANT AMPLITUDE LOADING (σ_{max} = 40 ksi, R = +0.1)

SPECIMEN NO. T-CA-2X,
THICKNESS (INCH) 0.3792,
WIDTH (INCH) 4.005,

HOLE #1 IF #2, δ = 0.0042", σ_b/σ_o = 0
HOLE #2 IF #2, δ = 0.0042", σ_b/σ_o = 0
HOLE #3 ONLY TWO HOLES

TOTAL CYCLES	CRACK LENGTH, C, INCH			TOTAL CYCLES	CRACK LENGTH, C, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
START	.019	.017		23000	.222	.155	
1000	.025	.022		23500	.233	.159	
2000	.027	.025		24000	.245	.166	
3000	.028	.028		24500	.258	.176	
4000	.031	.031		25000	.270	.181	
6000	.034	.034		25500	.284	.192	
8000	.037	.038		26000	.295	.200	
12000	.046	.052		26500	.307	.207	
16000	.096	.077		27500	.328	.224	
18000	.133	.094		28500	.360	.243	
19000	.156	.110		29500	.390	.269	
19500	.167	.115		30500		.296	
20500	.179	.124		31000		.304	
21000	.186	.129		31500		.317	
22000	.200	.141		32000		.327	
22500	.211	.147		32500		.342	

2. SPECTRUM LOAD TESTS - 2219-T851 ALUMINUM

This section contains the crack growth data of both corner crack and thru crack emanating from open, close-tolerance, interference-fit, and cold-worked fastener holes in 2219-T851 aluminum specimens subjected to both bomber and fighter spectra loading.

2.1 Bomber Spectrum - Corner Cracks

TABLE 57- GROWTH BEHAVIOR OF *CORNER* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO *BOMBER* SPECTRUM LOADING

SPECIMEN NO. A-BS-1,
THICKNESS(INCH) 0.4491,
WIDTH (INCH) 4.03,

HOLE #1 Neat-Fit with Load Transfer, $\sigma_b/\sigma_o = 1.15$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 Open Hole

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
1	.0056	.0034	.0056				
104	.0101	.0034	.0078				
209	.0112	.0056	.0090				
308	.0190	.0090	.0134				
394	.0258	.0112	.0157				
499	.0314	.0134	.0168				
604	.0482	.0157	.0213				
715	.0472	.0190	.0258				
862	.0907	.0224	.0314				
1010	.1422	.0291	.0392				
1092	.2587	.0448	.0470				
1130	.2587	.0470	.0504				

TABLE 58 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-05-2,
THICKNESS(INCH) 0.4498,
WIDTH (INCH) 4.01,

HOLE #1 TL #2, $\delta = 0.0038"$, $\sigma_b/\sigma_o = 1.08$
HOLE #2 TL #1, $\delta = 0.0024"$, $\sigma_b/\sigma_o = 0$
HOLE #3 TL #2, $\delta = 0.0038"$, $\sigma_b/\sigma_o = 0$

TOTAL FLIGHTS	CRACK LENGTH, INCH			TOTAL FLIGHTS	CRACK LENGTH, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0582	.0560	.0571				
58	.0616	.0616	.0650				
128	.0728	.0661	.0672				
244	.0885	.0683	.0739				
383	.1120	.0750	.0784				
503	.1355	.0795	.0885				
625	.1658	.0874	.0941				
762	.1938	.0918	.1019				
865 (1)	.1938	.0963	.1131				

(1) FAILURE THRU HOLE #1

TABLE 59- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-3,
THICKNESS(INCH) .4497,
WIDTH (INCH) 4.01,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 1.03
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0038", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0459	.0269	.0560				
55	.0526	.0347	.0638				
117	.0549	.0370	.0683				
209	.0531	.0358	.0661				
242	.0582	.0448	.0750				
363	.0627	.0538	.0795				
511	.0672	.0571	.0885				
656	.0683	.0706	.0930				
763	.0706	.0795	.1019				
901	.0750	.0930	.1075				
1039	.0829	.1086	.1142				
1159	.0907	.1232	.1266				
1276	.1042	.1434	.1389				
1375	.1221	.1568	.1490				
1492	.1411	.1792	.1646				
1599	.1602	.2072	.1792				
1702	.1781	.2352	.1938				
1801	.2027	.2732	.2117				

TABLE 60 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-4,
THICKNESS(INCH) 0.4503,
WIDTH (INCH) 4.00,

HOLE #1 2% c.w. – Load Transfer, $\sigma_b/\sigma_o = 1.12$
HOLE #2 2% c.w. – open
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0526	.0358					
38	.0672	.0426					
100	.0773	.0470					
180	.0896	.0549					
247	.1109	.0571					
307	.1266	.0594					
375	.1456	.0627					
455	.1691	.0672					
547	.2038	.0762					
599 (1)	.2419	.0840					
696	.2419	.0907					
801	.2419	.0974					
917	.2419	.1109					
992	.2419	.1232					
1106	.2419	.1344					
1241	.2419	.1579					
1350 (2)	.2419	.1826					

(1) HOLE #1 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #1

TABLE 61 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-5,
THICKNESS(INCH) 0.4508,
WIDTH (INCH) 4.01,

HOLE #1 2% CW - Neat-Fit, $\sigma_m/\sigma_o = 0$
HOLE #2 2% CW. - open
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
42	.0470	.0616					
187	.0672	.0739					
272	.0784	.0806					
344	.0896	.0885					
457	.1120	.1008					
600	.1445	.1109					
685	.1658	.1176					
777	.1882	.1288					
815	.2050	.1365					
850	.2162	.1400					
902	.2341	.1478					
950	.2509	.1568					
1002	.2733	.1624					
1100	.3158	.1792					
1220 (1)	.3942	.2072					

(1) TEST DISCONTINUED

TABLE 62 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-6,
THICKNESS(INCH) 0.4498,
WIDTH (INCH) 4.00,

HOLE #1 1L #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #3 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$

TOTAL FLIGHTS	CRACK LENGTH, INCH			TOTAL FLIGHTS	CRACK LENGTH, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
151	.0426	.0582	.0582				
350	.0459	.0627	.0638				
612	.0459	.0672	.0661				
854	.0459	.0683	.0672				
1121	.0459	.0683	.0683				
1467	.0470	.0683	.0717				
1944	.0470	.0706	.0750				
2450	.0482	.0750	.0795				
2994	.0504	.0784	.0840				
3507	.0526	.0818	.0896				

TABLE 63 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-7 ,
THICKNESS(INCH) 0.4481 ,
WIDTH (INCH) 4.00 ,

HOLE #1 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #2 Open Hole
HOLE #3 ONLY TWO TEST HOLES

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
108	.0067	.0078					
263	.0090	.0112					
458	.0134	.0179					
636	.0213	.0224					
823	.0235	.0370					
1100	.0291	.0482					
1311	.0381	.0762					
1500	.0459	.1120					
1601	.0549	.1344					
1711 (1)	.0706	.2016					
1781 (2)	.0851	.2016 (2)					

(1) CRACK INITIATED AT OTHER SIDE OF HOLE #2
(2) FAIL @ #2

TABLE 64 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-1X,
THICKNESS(INCH) 0.451,
WIDTH (INCH) 4.008,

HOLE #1 4% C.W. - open
HOLE #2 4% C.W - open
HOLE #3 only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0404	.0404		2924	.4054	2274	
55	.0504	.0526		2987	4424	2374	
300	.0638	.0672					
500	.0739	.0750					
700	.0840	.0818					
902	.0941	.0896					
1102	.1064	.0952					
1299	.1187	.1042					
1499	.1333	.1142					
1699	.1478	.1221					
1799	.1579	.1254					
1899	.1680	.1310					
2068	.1882	.1434					
2187	.2050	.1490					
2287	.2195	.1557					
2400	.2386	.1658					
2675	.3058	.1904					
2833	.3606	.2128					

2.2 Bomber Spectrum - Thru Cracks

TABLE 65 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-8,
THICKNESS(INCH) 0.450,
WIDTH (INCH) 6.006,

HOLE #1 Neat-Fit - Load Transfer, $\sigma_b/\sigma_o = .111$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 open Hole

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0101	.0090	.0134	373	.4805	.2811	.2498
22	.0336	.0213	.0258	385 (1)	.5130	.2968	.2610
35	.0504	.0280	.0302	406	.5130	.3270	.2923
49	.0605	.0336	.0370	421	.5130	.3461	.3058
76	.0829	.0493	.0515	422	.5130	.3763	.3270
100	.1008	.0605	.0605	464	.5130	.4099	.3629
123	.1221	.0728	.0717	481	.5130	.4357	.3730
144	.1422	.0851	.0851	497	.5130	.4682	.3998
167	.1613	.0974	.0952	509	.5130	.5062	.4301
193	.1859	.1165	.1086	521	.5130	.5275	.4503
229	.2274	.1445	.1322	532 (2)	.5130	.5477	.4659
252	.2554	.1602	.1478				
276	.2867	.1781	.1624				
298	.3203	.1971	.1814				
319	.3707	.2206	.2005				
330	.3898	.2307	.2072				
341	.4077	.2442	.2162				
362	.4570	.2677	.2386				

(1) STOP-DRILLED HOLE #1
(2) DISCONTINUED TESTING

TABLE CC - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO A-BS-9,
THICKNESS(INCH) 0.455,
WIDTH (INCH) 6.005,

HOLE #1 TL #2, δ = .038", σ_b/σ_o = 1.06
HOLE #2 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #3 TL #1, δ = 0.0024", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0045	.0045	.0045	1040 (1)	.0291	.4659	.0269
65	.0056	.0067	.0112	1381	.0336	.4659	.0314
160	.0067	.0146	.0123	1495	.0403	.4659	.0336
269	.0146	.0246	.0146	1817	.0403	.4659	.0370
392	.0190	.0359	.0168	2201	.0403	.4659	.0370
509	.0224	.0616	.0190	2505 (2)	.0403	.4659	.0370
597	.0224	.0840	.0202				
652	.0235	.1064	.0224				
731	.0258	.1445	.0235				
791	.0258	.1747	.0235				
825	.0258	.2072	.0246				
874	.0269	.2173	.0246				
889	.0269	.2542	.0246				
929	.0269	.3046	.0258				
955	.0269	.3282	.0258				
981	.0269	.3562	.0269				
1007	.0280	.3976	.0269				
1028	.0291	.4357	.0269				

(1) STOP-DRILLED HOLE #2
(2) SPECIMEN FAILED THRU HOLE #2

TABLE 67- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-05-10,
THICKNESS(INCH) 0.4487,
WIDTH (INCH) 6.02,

HOLE #1 TL#2, δ = 0.0038", σ_b/σ_o = 1.00
HOLE #2 TL#2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 TL#2, δ = 0.0038", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0022	.0056	.0045				
125		.0056					
251		.0056					
410		.0078					
558		.0090					
766							
986							
1306							
1605							
2070							
2480 ⚠	.0022	.0090	.0045				

⚠ SPECIMEN FAILED THRU HOLE #1

TABLE 68 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-11,
THICKNESS(INCH) 0.4496,
WIDTH (INCH) 4.00,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.02$
HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. -- open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0045	.0067	.0034	1200	.2755	.2475	.1680
45	.0213	.0146	.0112	1264 (2)	.2755	.2822	.1814
101	.0538	.0235	.0202				
141	.0694	.0302	.0224				
191	.0885	.0358	.0291				
251	.1019	.0426	.0370				
300	.1210	.0482	.0459				
350	.1378	.0549	.0515				
400	.1546	.0605	.0560				
454	.1680	.[illegible]2	.0616				
501	.1915		.0672				
549	.2050		.0706				
601	.2240		.0784				
651	.2475	.[illegible]1	.0818				
700 (1)	.2755	.1098	.0882				
800	.2755	.1232	.0997				
900	.2755	.1490	.1142				
999	.2755	.1714	.1288				
1100	.2755	.2072	.1445				

(1) HOLE #1 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #1

TABLE 69 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-12,
THICKNESS(INCH) 0.1493,
WIDTH (INCH) 4.01,

HOLE #1 2% c.w - Load Transfer, $\sigma_b/\sigma_o = .098$
HOLE #2 2% c.w - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0531	.0593	.0593				
53	.0941	.0574	.0885				
90	.1165	.0986	.0997				
135	.1467	.1109	.1176				
175	.1624	.1187	.1288				
212	.1904	.1288	.1445				
265	.2162	.1456	.1613				
318	.2464	.1680	.1803				
359	.2934	.1848	.1938				
400	.3248	.2038	.2117				
442 ⚠	.3651	.2262	.2307				

⚠ TEST DISCONTINUED AT PASS 442

TABLE 70 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-13,
THICKNESS(INCH) 0.4502,
WIDTH (INCH) 4.01,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.06$
HOLE #2 2% c.w. - Neat Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0056	.0022	.0034				
50	.0414	.0112	.0123				
94	.0683	.0224	.0235				
151	.0974	.0358	.0358				
200	.1142	.0459	.0459				
252	.1400	.0582	.0582				
366	.1792	.0896	.0907				
412	.2005	.1008	.1019				
456	.2173	.1120	.1131				
501 (1)	.2464	.1266	.1344				
607	.2464	.1669	.1758				
707	.2464	.2184	.2374				

(1) HOLE #1 STOP-DRILLED

TABLE 71 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-DS-14,
THICKNESS(INCH) 0.4497,
WIDTH (INCH) 4.00,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.13$
HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. - Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0513	.0617	.0545				
67	.1019	.0930	.0795				
102	.1221	.1109	.0896				
137	.1434	.1232	.1019				
170	.1568	.1355	.1131				
213	.1803	.1579	.1254				
268	.2094	.1848	.1445				
314	.2430	.2128	.1635				
360	.2834	.2430	.1826				
400	.3203	.2744	.2012				
440 △1	.3506	.3170	.2285				

△1 TEST DISCONTINUED AT PASS 440

TABLE 72 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-15,
THICKNESS(INCH) 0.450,
WIDTH (INCH) 6.007,

HOLE #1 2% c w - Load Transfer, $\sigma_b/\sigma_o = 1.03$
HOLE #2 2% c.w. - Neat Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.1276	.1595	.1496	359	.6292	.4510	.4367
20	.1595	.1870	.1727	368 (1)	.6567	.4642	.4499
36	.1760	.1991	.1815				
58	.1859	.2068	.2002				
87	.2035	.2200	.2024				
102	.2288	.2376	.2200				
123	.2596	.2530	.2321				
143	.2783	.2662	.2420				
167	.2948	.2772	.2574				
191	.3168	.2937	.2717				
212	.3531	.3080	.2959				
236	.3795	.3278	.3069				
257	.4059	.3421	.3190				
279	.4422	.3630	.3410				
305	.5071	.3982	.3817				
317	.5368	.4070	.3927				
327	.5522	.4169	.4037				
338	.5676	.4290	.4147				
349	.5907	.4367	.4257				

(1) DISCONTINUED TESTING

TABLE 73 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-16,
THICKNESS(INCH) 0.4496,
WIDTH (INCH) 4.01,

HOLE #1 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #3 4% C.W - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
26	.0336	.0381	.0493	1635	.0840	.2486	.2262
69	.0347	.0470	.0650	1785	.0862	.2699	.2262
112	.0381	.0549	.0773	1840 (2)	.0874	.2834	.2262
178	.0426	.0638	.0862				
242	.0448	.0706	.1064				
318	.0459	.0773	.1232				
390	.0482	.0874	.1355				
453	.0504	.0930	.1456				
540	.0538	.1042	.1579				
627	.0549	.1109	.1792				
737	.0594	.1243	.2016				
917 (1)	.0661	.1434	.2262				
1070	.0683	.1568					
1260	.0706	.1792					
1350	.0739	.1949					
1402	.0750	.2016					
1450	.0773	.2083					
1528	.0795	.2218					
1602	.0818	.2352	.2262				

(1) HOLE #3 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #3

TABLE 74 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-17,
THICKNESS(INCH) 0.4497,
WIDTH (INCH) 4.01,

HOLE #1 TL#3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL#3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #3 4% C.W. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0448	.0246	.0616	2023 (1)	.0762	.0246	.4458
13	.0470		.0683	2120 (2)	.0784	.0246	.4458
30	.0470		.0784				
52	.0470		.0806				
86	.0470		.0829				
104	.0470		.0829				
208	.0470		.0896				
333	.0470		.0930				
461	.0560		.1008				
647	.0594		.1120				
905	.0638		.1243				
1105	.0672		.1389				
1300	.0683		.1658				
1497	.0706		.1994				
1754	.0717		.2453				
1880	.0739		.3158				
1955	.0750		.3718				
1991	.0750	.0246	.4066				

(1) HOLE #3 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #3

TABLE 75 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-18,
THICKNESS(INCH) 0.450,
WIDTH (INCH) 6.010,

HOLE #1 5% c.w. - open
HOLE #2 5% c.w. - open
HOLE #3 4% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.1370	.1470	.1400				
11	.1400	.1470	.1450				
45	.1480	.1510	.1570				
108	.1600	.1630	.1820				
131	.1630	.1650	.1860				
179	.1680	.1670	.1960				
265	.1730	.1740	.2160				
353	.1790	.1790	.2260				
418	.1850	.1820	.2400				
520	.1890	.1870	.2660				
580	.1940	.1900	.2830				
623	.1950	.1920	.3030				
696	.1970	.1930	.3330				
744	.2010	.1970	.3750				
765	.2030	.1980	.3860				
789 ⚠1	.2050	.1990	.3990				
900	.2150	.2060	.3990				
1018	.2200	.2160	.3990				
1128	.2290	.2280	.3990				
1140 ⚠2	.2310	.2290	.3990				

⚠1 STOP-DRILLED HOLE #3
⚠2 FAILED THRU HOLE #3

TABLE 76 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-05-2X,
THICKNESS(INCH) 0.4488,
WIDTH (INCH) 4.016,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0.99
HOLE #2 Only One Test Hole
HOLE #3 "

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
120 ⚠	.0560			1317	.2934		
260	.0773			1337	.3035		
383	.0907			1326	.3170		
470	.1019			1385	.3293		
592	.1131			1407	.3506		
729	.1288						
839	.1411						
887	.1512						
919	.1590						
971	.1691						
1027	.1803						
1080	.2083						
1163	.2229						
1202	.2374						
1232	.2498						
1251	.2576						
1272	.2666						
1295	.2800						

⚠ INITIAL CRACK LENGTH @ PASS 1 WAS 0.0372 - INCH.

TABLE 77- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. A-BS-3X,
THICKNESS(INCH) 0.4531,
WIDTH (INCH) 4.01,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #2 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0146	.0246		3794	.0202	.3405	
95	.0146	.0314		3958 ⚠1	.0235	.3405	
460	.0168	.0392					
899	.0168	.0526					
1197	.0168	.0650					
1490	.0168	.0762					
1805	.0168	.0862					
2058	.0168	.0963					
2212	.0168	.1030					
2426	.0179	.1154					
2743	.0190	.1355					
1080	.0193	.0000					
1125	.0190	.1590					
2999	.0190	.1590					
3255	.0202	.2005					
3403	.0202	.2285					
3542	.0202	.2598					
3596	.0202	.2733					
3642	.0202	.2856					
3707	.0202	.3080					

⚠1 FAILURE HOLE #2

2.3 Fighter Spectrum - Corner Cracks

TABLE 78 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T351 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-1,
THICKNESS(INCH) 0.4501,
WIDTH (INCH) 4.00,

HOLE #1 Neat-Fit with Load-Transfer, $\sigma_b/\sigma_o = 0.93$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 Open Hole

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0045	.0056	.0045				
75	.0067	.0078	.0056				
200	.0157	.0101	.0090				
227	.0325	.0146	.0168				
251	.0571	.0202	.0291				
282	.1086	.0269	.0526				
307	.1635	.0358	.0795				
331	.2139	.0482	.1131				
348 ⚠	.2139	.0605	.1411				

⚠ FAILURE HOLE #1

TABLE 79 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-2
THICKNESS(INCH) 0.452
WIDTH (INCH) 4.005

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0.96
HOLE #2 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0038", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0515	.0504	.0392				
11	.0683	.0616	.0403				
25	.0829	.0728	.0403				
47	.0952	.0829	.0414				
70	.1053	.0952	.0426				
96	.1165	.1064	.0459				
117	.1254	.1176	.0470				
140	.1366	.1299	.0482				
160	.1422	.1400	.0493				
180	.1490	.1523	.0504				
202	.1624	.1725	.0515				
212	.1658	.1814	.0526				
222	.1702	.1870	.0526				
232	.1736	.1949	.0526				
245	.1803	.2072	.0526				
257 (1)	.1848	.2184	.0538				
486 (2)	.1848	.2184	.0538				

(1) CRACK STOP-DRILLED HOLE #1 & #2
(2) SPECIMEN FAILED THRU HOLE #2

TABLE 80 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-3,
THICKNESS(INCH) 0.448,
WIDTH (INCH) 4.004,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 0.91
HOLE #2 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0038", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
1	.0538	.0470	.0370	567	.2251	.1355	.0560
11	.0672	.0580	.0392	607	.2251	.1400	.0571
35	.0784	.0627	.0426				
70	.0918	.0706	.0470				
110	.1030	.0762	.0470				
154	.1142	.0806	.0470				
212	.1310	.0896	.0470				
240	.1378	.0918	.0482				
260	.1467	.0941	.0482				
281	.1546	.0986	.0493				
308	.1669	.1019	.0504				
325	.1747	.1030	.0504				
345	.1859	.1064	.0515				
365	.2005	.1086	.0515				
375	.2072	.1109	.0515				
385	.2150	.1120	.0515				
395	.2251	.1131	.0526				
464	.2251	.1232	.0538				

TABLE 81 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851, ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-4,
THICKNESS(INCH) 0.4502,
WIDTH (INCH) 4.00,

HOLE #1 2% c.w - Load Transfer, $\sigma_b/\sigma_o = 0.95$
HOLE #2 2% c.w - open
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0403	.0582					
8	.0549	.0706					
23	.0650	.0773					
48	.0818	.0885					
74	.0907	.0997					
107	.0997	.1120					
144	.1064	.1277					
175	.1198	.1445					
205	.1422	.1590					
232	.1568	.1781					
258	.1870	.1994					
279	.2162	.2150					
297	.2262	.3240					
301 ⚠	.2262	.2453					

⚠ SPECIMEN FAILED THRU HOLE #1

TABLE 82 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-5,
THICKNESS(INCH) 0.4506,
WIDTH (INCH) 4.00,

HOLE #1 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #2 2% c.w. - open
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0414	.0486		468	.2252	.2150	
18	.0560	.0594		488	.2554	.2307	
47	.0661	.0739		514	.2901	.2520	
69	.0739	.0795		537	.3416	.2744	
94	.0795	.0874					
119	.0851	.0930					
143	.0907	.0986					
162	.0986	.1019					
189	.1030	.1109					
214	.1142	.1154					
249	.1221	.1243					
279	.1333	.1344					
311	.1445	.1445					
346	.1557	.1568					
374	.1691	.1736					
400	.1882	.1803					
424	.1938	.2016					
443	.2150	.2050					

TABLE 83 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-6,
THICKNESS(INCH) 0.4498,
WIDTH (INCH) 4.01,

HOLE #1 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$
HOLE #3 TL #3, $\delta = 0.0060"$, $\sigma_b/\sigma_o = 0$

TOTAL FLIGHTS	CRACK LENGTH, INCH			TOTAL FLIGHTS	CRACK LENGTH, INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0426	.0470	.0549	1426	.0683	.1019	.2240
67	.0470	.0538	.0571	1505	.0683	.1042	.2240
109	.0504	.0571	.0661	1622	.0683	.1109	.2240
175	.0571	.0616	.0717	1693 (2)	.0683	.1154	.2240
220	.0594	.0627	.0750				
275	.0605	.0672	.0784				
346	.0605	.0750	.0806				
421	.0605	.0784	.0829				
483	.0616	.0806	.0874				
554	.0650	.0818	.0907				
701	.0683	.0851	.1053				
804	.0683	.0851	.1142				
904	.0683	.0851	.1310				
1002	.0683	.0851	.1523				
1111	.0683	.0851	.1893				
1191 (1)	.0683	.0896	.2240				
1308	.0683	.0963	.2240				

(1) HOLE #3 STOP-DRILLED
(2) FAILURE HOLE #3

2.4 Fighter Spectrum - Thru Cracks

TABLE 84 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-8,
THICKNESS(INCH) 0.447,
WIDTH (INCH) 6.006,

HOLE #1 Neat-Fit with Load Transfer, σ_t/σ_o = 1.08
HOLE #2 Neat-Fit, σ_t/σ_o = 0
HOLE #3 Open Hole

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0134	.0067	.0146	94	.4211	.1859	.1826
5	.0515	.0179	.0179	98 (1)	.4592	.1949	.1915
6	.0515	.0190	.0202	105	.4592	.2072	.1982
8	.0560	.0246	.0258	117	.4592	.2262	.2206
10	.0672	.0280	.0280	129	.4592	.2442	.2430
13	.0784	.0358	.0370	138	.4592	.2722	.2654
17	.0829	.0392	.0403		(2)		
25	.1266	.0571	.0538				
28	.1344	.0616	.0583				
31	.1422	.0627	.0638				
36	.1579	.0717	.0695				
42	.1792	.0829	.0795				
48	.1982	.0907	.0885				
56	.2240	.1042	.1098				
62	.2487	.1154	.1131				
69	.2688	.1288	.1243				
76	.3035	.1456	.1411				
83	.3405	.1613	.1579				
89	.3707	.1725	.1691				

(1) STOP-DRILLED HOLE #1
(2) SPECIMEN FAILED @ HOLE #1 DURING PASS 140

TABLE 85 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-9,
THICKNESS(INCH) 0.450,
WIDTH (INCH) 6.002,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 1.18
HOLE #2 TL #1, δ = 0.0024", σ_b/σ_o = 0
HOLE #3 TL #1, δ = 0.0024", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0123	.0023	.0023	219	.0986	.4491	.0190
7	.0202	.0112	.0045	227	.0986	.4726	.0190
15	.0426	.0151	.0056	233 (1)	.0997	.4850	.0190
29	.0448	.0359	.0078	249	.1019	.4850	.0202
46	.0526	.0560	.0078	265	.1053	.4850	.0202
60	.0605	.0717	.0134	303	.1109	.4850	.0202
73	.0650	.0851	.0134	323	.1131	.4850	.0202
86	.0683	.1042	.0146	353	.1221	.4850	.0203
99	.0728	.1254	.0146	383	.1327	.4850	.0224
112	.0762	.1456	.0157	385 (2)	.1322	.4850	.0224
127	.0784	.1680	.0157				
142	.0829	.2050	.0157				
150	.0896	.2307	.0168				
157	.0896	.2464	.0168				
165	.0896	.2710	.0168				
179	.0907	.3125	.0179				
191	.0930	.3640	.0179				
197	.0941	.3808	.0179				
206	.0986	.4144	.0190				
213	.0963	.4334	.0190				

(1) STOP-DRILLED HOLE #2
(2) SPECIMEN FAILED THRU HOLE #2

TABLE 86 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-10,
THICKNESS(INCH) 0.452,
WIDTH (INCH) 4.005,

HOLE #1 TL #2, δ = 0.0038", σ_b/σ_o = 1.07
HOLE #2 TL #2, δ = 0.0038", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0038", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
2	.0045	.0078	.0067	367	.1960	.0112	.1848
25	.0168	.0112	.0146	370	.2083		.1926
45	.0280	.0112	.0280	371	.2139		.1938
65	.0392		.0347	372	.2173		.1949
85	.0470		.0414	373 (1)	.2274		.1960
107	.0549		.0470	384	.2274		.2173
127	.0605		.0515	395 (1)	.2274		.2352
147	.0661		.0582	432 (2)	.2274	.0112	
167	.0728		.0650				
187	.0795		.0694				
207	.0840		.0739				
227	.0896		.0762				
247	.0963		.0840				
267	.1042		.0907				
288	.1120		.1042				
308	.1210		.1176				
323	.1299		.1298				
338	.1422		.1445				
348	.1557		.1579				
358	.1714		.1702				
363	.1837	.0112	.1781				

(1) STOP-DRILLED CRACK
(2) SPECIMEN FAILED THRU HOLE #1

TABLE 87- GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. A-FS-11,
THICKNESS(INCH) 0.4497,
WIDTH (INCH) 4.01,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = .096$
HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
1	.0045	.0045	.0067				
26	.0178	.0045	.0082				
53	.0571	0101	.0146				
76	.0806	.0190	.0246				
99	.1019	.0381	.0448				
128	.1198	.0437	.0538				
155	.1378	.0470	.0538				
197	.1590	.0672	.0582				
235	.2016	.0795	.0661				
270 ⚠	.2016	.0862	.0784				

⚠ FAILURE THRU HOLE #1

TABLE 88 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-12,
THICKNESS(INCH) 0.4498,
WIDTH (INCH) 4.00,

HOLE #1 2% c w - Load Transfer, σ_b/σ_o = .094
HOLE #2 2% c w - Neat F.t, σ_b/σ_o = 0
HOLE #3 2% c w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0470	.0336	.0549				
11	.0930	.0504	.0885				
17	.1030	.0582	.0941				
27	.1221	.0650	.1064				
39	.1501	.0728	.1210				
51	.1691	.0795	.1310				
67	.1870	.0851	.1434				
86	.2162	.0974	.1568				
101	.2442	.1064	.1691				
115 (1)	.2867	.1131	.1837				
128	.2867	.1232	.2016				
143 (2)	.2867	.1310	.2016				
160	.2867	.1411	.2016				
169 (3)	.2867	.1478	.2016				

(1) HOLE #1 STOP-DRILLED
(2) HOLE #3 STOP-DRILLED
(3) FAILURE THRU HOLE #1

TABLE 89- GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. A-FS-13,
THICKNESS(INCH) 0.4498,
WIDTH (INCH) 4.00,

HOLE #1 2% CW - Load Transfer $\sigma_b/\sigma_o = .098$
HOLE #2 2% CW - Neat-Fit $\sigma_b/\sigma_o = 0$
HOLE #3 2% CW - Open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
1	.0011	.0045	.0056	250 (2)	.2822	.1389	.1366
6	.0224	.0134	.0123				
9	.0336	.0202	.0179				
16	.0515	.0269	.0280				
24	.0683	.0370	.0358				
33	.0795	.0414	.0437				
42	.0930	.0482	.0482				
54	.1042	.0571	.0549				
62	.1154	.0605	.0594				
78	.1266	.0694	.0672				
89	.1378	.0773	.0717				
101	.1490	.0840	.0784				
117	.1646	.0918	.0851				
135	.1882	.0986	.0918				
150	.2016	.1042	.0974				
172	.2397	.1142	.1053				
188 (1)	.2822	.1198	.1120				
213	.2822	.1288	.1210				

(1) HOLE #1 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #1

TABLE 90 - GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. *A-FS-14*,
THICKNESS(INCH) *0.451*,
WIDTH (INCH) *4.006*,

HOLE #1 *2% c.w - Load Transfer* $\sigma_b/\sigma_0 = 0.94$
HOLE #2 *2% c.w - Neat-Fit* $\sigma_b/\sigma_0 = 0$
HOLE #3 *2% c.w - open*

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0560	.0426	.0515	130	.2363	.2706	.2229
8	.1075	.0661	.0661				
10	.1254	.0694	.0694				
14	.1378	.0739	.0728				
17	.1572	.0773	.0784				
20	.1736	.0851	.0840				
23	.1859	.0874	.0907				
27	.2061	.0896	.0941				
30	.2195	.0918	.0952				
35 ⚠	.2363	.1008	.0974				
54	.2363	.1109	.1142				
75	.2363	.1254	.1266				
95	.2363	.1400	.1434				
115	.2363	.1557	.1602				
135	.2363	.1747	.1747				
155	.2363	.1926	.1960				
170	.2363	.2106	.2139				

⚠ HOLE #1 STOP-DRILLED

TABLE 91 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-15,
THICKNESS(INCH) 0.45,
WIDTH (INCH) 6.006,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.20$
HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.1613	.1266	.1366				
6	.2576	.1534	.1635				
8	.2766	.1590	.1669				
11	.3035	.1658	.1770				
17	.3483	.1803	.1882				
20	.3730	.1859	.1915				
23	.3976	.1915	.1994				
26	.4133	.1960	.2005				
30	.4379	.2005	.2027				
34	.4626	.2072	.2072				
38 (1)	.4861	.2117	.2128				
47	.4861	.2229	.2218				
59	.4861	.2397	.2341				
75	.4861	.2598	.2509				
100	.4861	.2990	.2766				
119	.4861	.3326	.3002				
135	.4861	.3741	.3237				
145 (2)	.4861	.3987	.3349				

(1) HOLE #1 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #1

TABLE 92 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-16,
THICKNESS(INCH) 0.4499,
WIDTH (INCH) 4.01,

HOLE #1 TL #3, δ = 0.0060", σ_L/σ_o = 0
HOLE #2 TL #3, δ = 0.0060", σ_L/σ_o = 0
HOLE #3 4% C.W. – open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0426	.0370	.0560	1403 (2)	.2173	.0717	.2251
33	.0426	.0370	.0773	1564	.2173	.0717	.2251
60	.0470	.0414	.0818	1621	.2173	.0717	.2251
92	.0493	.0482	.0885				
118	.0504	.0504	.0918				
194	.0504	.0526	.1019				
251	.0616	.0549	.1109				
303	.0661	.0560	.1142				
370	.0717	.0571	.1254				
523	.0795	.0594	.1478				
642	.0851	.0594	.1770				
716	.0885	.0638	.2240				
782 (1)	.0918	.0661	.2251				
893	.0941	.0672	.2251				
1003	.1008	.0672	.2251				
1121	.1030	.0683	.2251				
1237	.1198	.0706	.2251				
1353	.1579	.0717	.2251				

(1) CRACK STOP-DRILLED HOLE #3
(2) HOLE #1 STOP-DRILLED

TABLE 93 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. B-FS-17,
THICKNESS(INCH) 0.4496,
WIDTH (INCH) 4.00,

HOLE #1 TL #3, δ = 0.0060", σ_b/σ_o = 0
HOLE #2 TL #3, δ = 0.0060", σ_b/σ_o = 0
HOLE #3 4% C.W. – open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0347	.0504	.0448				
81	.0426	.0594	.0638				
182	.0504	.0661	.0829				
249	.0526	.0683	.0974				
349	.0582	.0750	.1109				
452	.0672	.0840	.1232				
543	.0728	.0918	.1333				
663	.0806	.1232	.1534				
766 (1)	.1008	.2352	.1803				
836 (2)	.1053	.2352	.2150				
915	.1075	.2352	.2150				
943 (3)	.1098	.2352	.2150				

(1) HOLE #2 STOP-DRILLED (2) HOLE #3 STOP-DRILLED
(3) FAILURE @ HOLE #3

TABLE 94 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-ES-18,
THICKNESS(INCH) 0.452,
WIDTH (INCH) 6.006,

HOLE #1 5% c.w. - open
HOLE #2 5% c.w - open
HOLE #3 4% c.w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.1030	.1035	.1949	291 (1)	.1826	.1826	.5343
3	.1187	.1255	.2128	313	.1870	.1837	.5343
9	.1232	.1288	.2240	340	.1904	.1870	.5343
16	.1277	.1322	.2274	342 (2)	.1904	.1982	.5343
24	.1310	.1366	.2341				
41	.1366	.1411	.2453				
55	.1422	.1445	.2498				
73	.1478	.1501	.2610				
96	.1523	.1534	.2744				
128	.1568	.1613	.2979				
148	.1602	.1624	.3102				
177	.1680	.1658	.3315				
200	.1691	.1702	.3506				
221	.1714	.1714	.3740				
237	.1758	.1736	.3998				
25?	.1781	.1770	.4346				
270	.1792	.1792	.4570				
281	.1803	.1803	.4950				

(1) HOLE #3 STOP-DRILLED
(2) SPECIMEN FAILED THRU HOLE #3

TABLE 95- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 2219-T851 ALUMINUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. A-FS-1X,
THICKNESS(INCH) 0.4512,
WIDTH (INCH) 4.015,

HOLE #1 TL #1, δ = 0.0024", $\sigma_b/\sigma_o = 0$
HOLE #2 TL #1, δ = 0.0024", $\sigma_b/\sigma_o = 0$
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0112	.0134		911	.2598	.0515	
10	.0179	.0179		932	.2845	.0515	
20	.0235	.0190		984 (1)	.2845	.0526	
40	.0291	.0224		1020	.2845	.0538	
60	.0325	.0235		1040 (2)	.2845	.0538	
91	.0381	.0258					
130	.0459	.0291					
180	.0538	.0336					
230	.0616	.0358					
280	.0672	.0370					
330	.0739	.0375					
380	.0795	.0381					
437	.0885	.0403					
501	.0974	.0403					
575	.1053	.0437					
610	.1131	.0437					
671	.1266	.0448					
735	.1467	.0459					
778	.1635	.0470					
824	.1848	.0482					
889	.2374	.0515					

(1) DISCONTINUED READING HOLE #1
(2) FAILURE AT HOLE #1

TABLE 96 - GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *2219-T851 ALUMINUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. A-FS-2X,
THICKNESS(INCH) 0.4608,
WIDTH (INCH) 4.006,

HOLE #1 TL #2, $\delta = 0.0038$", $\sigma_b/\sigma_o = 0$
HOLE #2 TL #2, $\delta = 0.0038$", $\sigma_b/\sigma_o = 0$
HOLE #3 Only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
1	.0078	.0101		1326	.0750	.0280	
14	.0190	.0123		1381	.0840	.0280	
30	.0190	.0123		1437	.1086	.0302	
133	.0190	.0168		1478	.1579	.0325	
180	.0202	.0168		1492	.1792	.0325	
259	.0213	.0202		1502	.2005	.0336	
319	.0224	.0224		1511	.2139	.0336	
379	.0235	.0224		1520	.2386	.0336	
545	.0314	.0224		1529	.2531	.0336	
617	.0358	.0224		1539	.2755	.0336	
650	.0370	.0224		1563	.3270	.0336	
702	.0403	.0224		1571	.3472	.0336	
750	.0426	.0224					
798	.0437	.0235					
899	.0470	.0235					
1020	.0504	.0235					
1124	.0549	.0246					
1202	.0605	.0258					
1244	.0638	.0280					
1290	.0672	.0280					

3. SPECTRUM LOAD TESTS - 6Al-4V BETA ANNEALED TITANIUM

This section contains the crack growth data of both corner crack and thru crack emanating from open, close-tolerance, interference-fit, and cold-worked fastener holes in 6Al-4V beta annealed titanium specimens subjected to both bomber and fighter spectra loading.

3.1 Bomber Spectrum - Corner Cracks

TABLE 97- GROWTH BEHAVIOR OF *CORNER* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *6AL-4V βA TITANIUM* ALLOY PLATE SUBJECTED TO *BOMBER* SPECTRUM LOADING

SPECIMEN NO. *I-B3-1*,
THICKNESS(INCH) *0.376*,
WIDTH (INCH) *4.014*,

HOLE #1 *Neat-Fit with Load Transfer,* $\sigma_b/\sigma_o = 1.00$
HOLE #2 *Neat-Fit,* $\sigma_b/\sigma_s = 0$
HOLE #3 *open Hole*

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0011	.0023	.0045	1600	.3875	.0963	.0605
508	.0190	.0023	.0045	1667	.3875	.1086	.0638
540	.0213	.0023	.0045	1719	.3875	.1198	.0851
584	.0246	.0112	.0045	1787	.3875	.1310	.0997
705	.0347	.0146	.0056	1817 (2)	.3875	.1366	.0997
772	.0448	.0179	.0079				
840	.0638	.0224	.0079				
921	.0818	.0269	.0101				
984	.1030	.0269	.0112				
1056	.1411	.0302	.0202				
1089	.1658	.0314	.0202				
1138	.2274	.0347	.0202				
1169	.2610	.0359	.0224				
1189	.2946	.0381	.0224				
1205	.3293	.0403	.0224				
1225	.3651	.0426	.0235				
1234 (1)	.3875	.0448	.0246				
1314	.3875	.0583	.0280				
1476	.3875	.0750	.0392				

(1) HOLE #1 STOP-DRILLED
(2) FAILURE @ HOLE #1

TABLE 98 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-2,
THICKNESS(INCH) 0.375,
WIDTH (INCH) 3.997,

HOLE #1 TL#2, δ=.00042", σ_b/σ_o = 1.00
HOLE #2 TL#1, δ=.0034", σ_b/σ_o = 0
HOLE #3 TL#2, δ=.0042", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0482	.0616	.0672	1307 (1)	.4962	.2531	.0918
180	.0661	.0750	.0683	1415		.2789	.0941
323	.0862	.0840	.0739	1486		.3024	.0963
389	.1042	.0952	.0750	1537		.3192	.0974
459	.1131	.0963	.0762	1600		.3405	.1019
564	.1288	.1086	.0795	1675		.3763	.1064
707	.1557	.1288	.0840	1702		.3987	.1064
814	.1826	.1445	.0862	1731		.4155	.1075
861	.1994	.1490	.0874	1784		.4458	.1120
910	.2162	.1557	.0896	1816		.4626	.1131
972	.2386	.1680	.0896	1854 (2)		.4962	.1142
1032	.2766	.1792	.0896	2010			.1277
1076	.2834	.1870	.0896	2127			.1434
1143	.3214	.2050	.0896	2185			.1478
1193	.3539	.2195	.0896	2320			.1647
1248	.4099	.2341	.0907	2412			.1792
1266	.4312	.2442	.0907	2542			.1859
1291	.4715	.2531	.0907	2623 (3)	.4962	.4962	.2106

(1) STOP-DRILLED HOLE #1
(2) STOP-DRILLED HOLE #2
(3) FAILURE @ HOLE #1

TABLE 99 - GROWTH BEHAVIOR OF *CORNER* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *6AL-4V βA TITANIUM* ALLOY PLATE SUBJECTED TO *BOMBER* SPECTRUM LOADING

SPECIMEN NO. T-BS-3,
THICKNESS(INCH) 0.379,
WIDTH (INCH) 4.000,

HOLE #1 TL*2, δ = 0.0042", σ_b/σ_o = 1.00
HOLE #2 TL*1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 TL*2, δ = 0.0042", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0661	.0627	.0459	1110	.3842	.5230	.1120
57	.0750	.0762	.0459	1151	.4155		.1120
133	.0840	.0885	.0459	1176	.4435		.1142
209	.0918	.0997	.0549	1211	.4783		.1142
300	.1165	.1176	.0582	1238 (2)	.5118		.1165
376	.1176	.1333	.0594	1328	|		.1277
450	.1333	.1546	.0594	1378	|		.1333
500	.1501	.1725	.0638	1492	|		.1478
589	.1714	.2117	.0706	1511 (3)	.5118	.5230	.1512
663	.1949	.2464	.0750				
721	.2117	.2800	.0795				
771	.2251	.3102	.0818				
827	.2386	.3551	.0840				
865	.2453	.3909	.0862				
903	.2542	.4166	.0907				
930	.2722	.4446	.0907				
951	.2856	.4704	.1019				
975	.2990	.5118	.1019				
1000 (1)	.3147	.5230	.1019				
1025	.3248	.5230	.1019				
1080	.3584	.5230	.1042				

(1) STOP-DRILLED HOLE #2
(2) STOP-DRILLED HOLE #1
(3) FAILURE @ HOLE #1

TABLE 100 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-4,
THICKNESS(INCH) 0.370,
WIDTH (INCH) 4.005,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0.97$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0$
HOLE #3 4% C.W. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0594	.0504	.0459	2704	.3965	.4043	.2419
292	.0650	.0683	.0515	2733	.4413	.4155	.2520
610	.0728	.0806	.0549	2750	.4950	.4234	.2598
784	.0806	.0907	.0571	2770 (1)	.5645	.4334	.2766
1068	.0941	.1098	.0627	2845	.5645	.4334	.3058
1320	.1120	.1277	.0650	2884 (2)	.5645	.4334	.3293
1449	.1176	.1400	.0717				
1589	.1243	.1534	.0750				
1782	.1366	.1747	.0818				
2008	.1546	.2094	.0963				
2116	.1691	.2307	.1075				
2249	.1859	.2587	.1277				
2359	.1971	.2822	.1434				
2460	.2206	.3125	.1714				
2544	.2542	.3394	.1837				
2611	.2890	.3618	.1994				
2653	.3226	.3942	.2117				
2680	.3573	.3965	.2206				

(1) HOLES #1 & #2 STOP-DRILLED
(2) FAILURE THRU HOLE #1

TABLE 101 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-5,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 4.003,

HOLE #1 5% cw - open
HOLE #2 5% cw - open
HOLE #3 4% cw - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0469	.0706	.0426	2560	.0997	.0952	.2733
40	.0493	.0750	.0482	2600	.1008	.0952	.2901
110	.0526	.0784	.0486	2670 ①	.1008	.0952	.3371
397	.0571	.0818	.0493	2715	.1019	.0963	.3741
693	.0594	.0851	.0588	2967	.1042	.0986	.3741
936	.0638	.0896	.0583	3146	.1142	.0986	
1615	.0739	.0918	.0717	3401	.1288	.0997	
1766	.0773	.0930	.0818	3541	.1467	.1019	
1872	.0795	.0930	.0941	3649	.1602	.1019	
1968	.0818	.0930	.1053	3709	.1691	.1019	
2088	.0851	.0936	.1187	3744 ②	.1714	.1030	.3741
2173	.0874	.0930	.1333				
2265	.0885	.0941	.1590				
2317	.0885	.0941	.1747				
2365	.0896	.0941	.1882				
2411	.0907	.0941	.2106				
2458	.0963	.0941	.2262				
2521	.0997	.0941	.2531				

① STOP-DRILLED HOLE # 3

② FAILURE @ HOLE # 3

TABLE 102- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-6,
THICKNESS(INCH) 0.374,
WIDTH (INCH) 4.003,

HOLE #1 2% c w. - Load Transfer, $T_b/\sigma_o = 1.00$
HOLE #2 2% c w - Neat F.t, $T_b/\sigma_o = 0$
HOLE #3 2% c w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0560	.0482	.0336	982	.5063	.3330	.1579
130	.0829	.0638	.0471	1018		.2722	.1994
204	.1008	.0695	.0515	1088		.3058	.2341
273	.1258	.0750	.0560	1118		.3203	.2498
304	.1344	.0784	.0638	1160		.3573	.2822
385	.1714	.0918	.0695	1192		.3808	.3069
494	.2117	.1086	.0795	1234		.4077	.3237
535	.2352	.1210	.0851	1272		.4413	.3382
597	.2800	.1310	.0930	1312		.4704	.3562
626	.3058	.1366	.1030	1343		.4962	.3831
662	.3360	.1568	.1042	1366		.5163	.4066
686	.3573	.1635	.1042	1397		.5488	.4323
722	.3976	.1714	.1086	1400 (2)	.5063	.5522	.4357
743	.4200	.1758	.1154				
760	.4402	.1814	.1198				
779	.4615	.1837	.1243				
796	.4895	.1926	.1266				
807 (1)	.5063	.1938	.1322				
863	.5063	.2106	.1456				

(1) HOLE #1 STOP-DRILLED
(2) FAILURE @ HOLE #1

TABLE 103- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-7,
THICKNESS(INCH) 0.373,
WIDTH (INCH) 4.000;

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w. - Neat Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0493	.0583	.0706	710	.3909	.2386	.2890
20	.0583	.0616	.0728	740	.4054	.2509	3058
60	.0650	.0706	.0806	780	.4480	.2722	.3360
100	.0784	.0728	.0829	820	.4928	.2934	.3618
140	.0818	.0739	.0896	860	.5746	.3181	.3942
180	.0930	.0795	.0986	900	.6709	.3427	.4334
220	.1053	.0896	.1042				
260	.1198	.0974	.1142				
300	.1344	.1053	.1254				
340	.1568	.1131	.1299				
380	.1714	.1232	.1328				
420	.1904	.1366	.1546				
468	.2128	.1501	.1702				
510	.2352	.1658	.1882				
550	.2576	.1814	.2038				
590	.2778	.1926	.2218				
631	.3091	.2061	.2408				
670	.3472	.2173	.2610				

3.2 Bomber Spectrum - Thru Cracks

TABLE 104 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-8,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 5.016,

HOLE #1 Neat-Fit, Load Transfer, $\sigma_b/\sigma_o = 0.98$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 open Hole

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0045	.0157	.0045	362	.2722	.2083	.1624
16	.0190	.0157	.0112	390	.3013	.2173	.1758
28	.0291	.0157	.0123	430	.3450	.2531	.1994
38	.0437	.0179	.0179	459	.3786	.2710	.2240
49	.0515	.0202	.0190	490	.4155	.3013	.2442
60	.0605	.0336	.0269	520	.4637	.3237	.2654
70	.0672	.0370	.0280	550	.5051	.3550	.2822
81	.0717	.0482	.0291	580	.5746	.3909	.3091
92	.0862	.0526	.0302	610	.6742	.4245	.3528
105	.0874	.0594	.0358				
116	.0907	.0616	.0403				
135	.1008	.0683	.0470				
154	.1086	.0840	.0549				
171	.1165	.0862	.0650				
190	.1333	.0963	.0773				
211	.1400	.1075	.0795				
236	.1557	.1187	.0907				
270	.1837	.1355	.1053				
332	.2386	.1747	.1523				

TABLE 105- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-DS-10,
THICKNESS(INCH) 0.379,
WIDTH (INCH) 4.001,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 1.00
HOLE #2 TL #2, δ = 0.0042", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0042", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0560	.0594	.0818	1170	.1344	.2800	.3562
59	.0594	.0706	.0862	1237	.1456		
121	.0672	.0806	.0974	1376	.1658		
210	.0717	.0918	.1075	1459	.1792		
284	.0717	.1086	.1154	1581	.1938		
372	.0806	.1232	.1266	1659	.2061		
472	.0818	.1378	.1546	1742	.2352		
518	.0874	.1456	.1669	1820	.2542		
561	.0874	.1568	.1781	1929	.2867	.2800	.3562
603	.0874	.1658	.1804				
652	.0930	.1792	.2050				
693	.0941	.1882	.2150				
735	.0997	.1971	.2307				
774	.0997	.2061	.2430				
805	.1008	.2173	.2509				
854	.1030	.2330	.2722				
876	.1053	.2386	.2834				
984 ⚠	.1086	.2800	.3562				
1062	.1254	.2800	.3562				

⚠ STOP-DRILLED HOLE # 2 & #3

TABLE 106- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-11,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 4.003,

HOLE #1 2% c.w. - Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w., Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0638	.0504	.0728	420	.3461	.3035	.3562
30	.0829	.0638	.0896	440	.3685	.3158	.3752
61	.0918	.0739	.1042	460	.3931	.3338	.3987
72	.1075	.0851	.1109	481	.4245	.3573	.4245
93	.1165	.0963	.1198				
124	.1355	.1075	.1355				
152	.1490	.1187	.1478				
174	.1557	.1310	.1658				
197	.1758	.1422	.1781				
231	.2050	.1590	.1994				
253	.2229	.1736	.2117				
274	.2363	.1814	.2285				
295	.2419	.2072	.2442				
316	.2486	.2206	.2621				
337	.2565	.2374	.2755				
358	.2822	.2531	.2957				
379	.3046	.2666	.3159				
399	.3237	.2867	.3394				

TABLE 107- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VβA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-12,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 3.998,

HOLE #1 2% c.w., Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w., Neat-F.t, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w., open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0090	.0112	.0090	512	.3394	.1030	.1557
37	.0202	.0134	.0090	536	.3640	.1109	.1736
70	.0336	.0224	.0090	556	.3875	.1176	.1870
120	.0560	.0280	.0090	580	.4200	.1255	.2050
148	.0717	.0325	.0090	602	.4581	.1355	.2240
167	.0818	.0347	.0090	626 (1)		.1400	.2442
199	.0975	.0392	.0090	647		.1467	.2654
229	.1120	.0470	.0202	671		.1579	.2878
256	.1277	.0493	.0280	694		.1624	.3046
283	.1434	.0515	.0538	715		.1747	.3237
316	.1669	.0594	.0638	736		.1814	.3450
332	.1859	.0627	.0706	754		.1870	.3774
359	.2072	.0694	.0784	777		.1938	.3797
388	.2285	.0750	.0963	797		.2027	.4200
421	.2531	.0806	.1154	816		.2117	.4346
445	.2722	.0840	.1310	839 (3)		.2184	.4547
467	.2867	.0918	.1322	874		.2318	
488	.3125	.0952	.1445	907		.2464	
				911 (2)	.4581	.2475	.4547

(1) STOP-DRILLED HOLE #1
(2) FAILURE @ HOLE #3
(3) STOP-DRILLED HOLE #3

TABLE 108 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-13,
THICKNESS(INCH) 0.375,
WIDTH (INCH) 3.999,

HOLE #1 2% c.w., Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w. - Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w., Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0045	.0034	.0034	552	.2509	.2038	.2509
23	.0045	.0101	.0034	580	.2856	.2285	.2800
60	.0045	.0112	.0134	601	.3024	.2442	.3058
102	.0045	.0168	.0224	630	.3360	.2643	.3282
136	.0045	.0246	.0302	657	.3696	.2867	.3494
171	.0202	.0291	.0403	679	.3920	.3069	.3606
200	.0347	.0347	.0538	700	.4234	.3326	.3853
230	.0560	.0448	.0695	720	.4402	.3517	.4133
255	.0605	.0493	.0784				
280	.0762	.0560	.0874				
310	.0818	.0672	.1042				
340	.1042	.0818	.1232				
370	.1116	.0986	.1389				
400	.1472	.1120	.1523				
430	.1562	.1344	.1758				
460	.1870	.1568	.1882				
490	.2173	.1680	.2173				
520	.2352	.1837	.2397				

TABLE 109- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-14,
THICKNESS(INCH) 0.377,
WIDTH (INCH) 3.996,

HOLE #1 2% c.w. Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w. Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w. Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0325	.0448	.0672	643	.5499	.3763	.5421
29	.0571	.0571	.0818	659	.5746	.3842	.5578
64	.0650	.0672	.0952	674	.6082	.3987	.5790
112	.0918	.0829	.1154	689	.6440	.4178	.5970
156	.1053	.0963	.1344	705	.7045	.4312	.6272
196	.1243	.1109	.1613	716	.7459	.4413	.6418
237	.1445	.1266	.1859	734	.8266	.4592	.6709
289	.1781	.1512	.2262	758 ⚠1	.8266	.4794	.7247
330	.2139	.1736	.2587				
373	.2386	.1938	.2822				
413	.2744	.2285	.3159				
441	.2934	.2419	.3326				
474	.3315	.2643	.3730				
521	.3741	.2901	.4032				
540	.3942	.2990	.4245				
567	.4323	.3203	.4424				
601	.4738	.3528	.4883				
619	.5074	.3640	.5074				

⚠1 FAILURE @ HOLE #1

TABLE 110 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. I-BS-15,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 5.012,

HOLE #1 2% C.W., Load Transfer, $\sigma_b/\sigma_o = 0.92$
HOLE #2 2% C.W., Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% C.W., Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.1456	.1781	.1781	411	.5589	.5230	.5320
15	.1669	.1949	.1938	430	.5712	.5443	.5746
32	.1792	.2016	.2094				
51	.2016	.2150	.2117				
66	.2139	.2206	.2218				
84	.2285	.2240	.2397				
117	.2509	.2352	.2587				
145	.2789	.2621	.2934				
173	.3114	.2789	.3058				
195	.3349	.2946	.3237				
216	.3528	.3181	.3439				
236	.3685	.3360	.3513				
257	.3898	.3562	.3752				
279	.4133	.3786	.3898				
301	.4379	.4021	.4111				
330	.4738	.4301	.4334				
355	.4939	.4536	.4514				
383	.5219	.4883	.5029				

TABLE III - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-16,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 4.002,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0$
HOLE #3 4% C.W. - open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0325	.0213	.0493	1299	.0493	.0258	.4838
23	.0336	.0235	.0582	1323 (1)	.0493	.0258	.5197
63	.0381	.0246	.0683	1692	.0616	.0269	.5197
109	.0403	.0246	.0694	1772	.0661	.0269	.5197
335	.0403	.0246	.0861	1780 (2)	.0661	.0269	.5197
524	.0437	.0246	.1030				
637	.0437	.0246	.1232				
744	.0459	.0246	.1478				
787	.0459	.0246	.1669				
869	.0471	.0246	.1994				
909	.0471	.0246	.2106				
950	.0482	.0258	.2453				
1013	.0482	.0258	.2677				
1061	.0482	.0258	.2968				
1110	.0482	.0258	.3461				
1156	.0482	.0258	.3718				
1185	.0482	.0258	.3909				
1230	.0493	.0258	.4222				
1254	.0493	.0258	.4435				

(1) STOP-DRILLED HOLE #3
(2) FAILURE - HOLE #3

TABLE 12 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-DS-17,
THICKNESS(INCH) 0.379,
WIDTH (INCH) 3.997,

HOLE #1 TL #3, δ = 0.0050", $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, δ = 0.0050", $\sigma_b/\sigma_o = 0$
HOLE #3 4% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0414	.0291	.0795	1019	.0650	.0526	.5298
29	.0448	.0403	.0851	1169	.0672	.0538	.5298
76	.0459	.0414	.0918	1423	.0762	.0638	.5298
170	.0526	.0414	.1030	1534 (2)	.0795	.0638	.5298
255	.0526	.0414	.1098				
345	.0538	.0414	.1254				
430	.0549	.0414	.1445				
532	.0549	.0414	.1938				
577	.0549	.0414	.2106				
619	.0582	.0414	.2374				
668	.0582	.0414	.2710				
706	.0605	.0414	.3024				
732	.0605	.0414	.3181				
769	.0605	.0459	.3461				
803	.0627	.0470	.3831				
823	.0627	.0470	.4032				
846	.0638	.0493	.4469				
867	.0638	.0526	.4682				
918 (1)	.0638	.0526	.5298				

(1) STOP-DRILLED HOLE #3
(2) FAILURE - HOLE #3

TABLE #3 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4V BA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-18,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 5.005,

HOLE #1 5% c.w - open
HOLE #2 5% c.w - open
HOLE #3 4% c.w - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.1714	.1714	.1826				
28	.1848	.1837	.1938				
71	.1893	.1949	.2094				
111	.1938	.2005	.2195				
151	.1971	.2050	.2341				
255	.2184	.2218	.2643				
319	.2363	.2363	.2923				
369	.2475	.2487	.3136				
435	.2834	.2800	.3550				
468	.3080	.2946	.3763				
499	.3203	.3136	.3987				
533	.3360	.3394	.4133				
559	.3539	.3573	.4424				
602	.3752	.3864	.4626				
644	.3931	.4032	.4816				
685	.4200	.4301	.5107				
727	.4693	.4603	.5488				
758	.4984	.4962	.5869				

TABLE 114- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V BA TITANIUM ALLOY PLATE SUBJECTED TO BOMBER SPECTRUM LOADING

SPECIMEN NO. T-BS-1X,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 4.010,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_c = 0$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_c = 0$
HOLE #3 only Two Test Holes

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0500	.0380		1880	.3220	.1530	
68	.0620	.0450		1921	.3430	.1640	
565	.0720	.0540		1942 ⚠	.3600	.1700	
714	.0820	.0570		2022		.1920	
911	.0920	.0610		2085		.2160	
1122	.030	.0670		2133		.2300	
1239	.1200	.0850		2178		.2480	
1329	.1300	.0880		2237		.2700	
1394	.1420	.0890		2265		.2850	
1473	.1500	.0910		2302		.2950	
1546	.1730	.0970		2349	.3600	.3100	
1583	.1830	.1010					
1609	.1950	.1050					
1658	.2050	.1100					
1684	.2100	.1140					
1720	.2400	.1200					
1756	.2500	.1260					
1797	.2720	.1350					
1838	.2930	.1440					

⚠ STOP-DRILLED HOLE #1

3.3 Fighter Spectrum - Corner Cracks

TABLE 115 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VβA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-1,
THICKNESS(INCH) 0.377,
WIDTH (INCH) 4.003,

HOLE #1 Neat-Fit, Load Transfer, σ_b/σ_o = 1.00
HOLE #2 Neat-Fit, σ_b/σ_o = 0
HOLE #3 Open Hole

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
50	.0101	.0034	.0056				
219	.0190	.0067	.0112				
265 (1)	.0370	.0079	.0134				
290	.0627	.0123	.0146				
305	.0784	.0134					
316	.0963						
330	.1333						
335	.1478						
340	.1635	.0134					
345	.1949	.0146					
349	.2027	.0168					
356 (2)	.2487	.0168	.0146				
511	.2487	.0280	.0269				
531 (3)	.2487	.0280	.0269				

(1) A CRACK STARTED ON BOTH SIDES OF THE HOLE & GREW APPROX. THE SAME (HOLE #1)
(2) STOP-DRILLED BOTH CRACKS (HOLE #1) (3) FAILURE @ HOLE #1

TABLE 116 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VBA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-2,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 4.015,

HOLE #1 TL #2, δ=.00042", σ_b/σ_o = 1.00
HOLE #2 TL #1, δ=.00034", σ_b/σ_o = 0
HOLE #3 TL #2, δ=.00042", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0717	.0403	.0470	410	.2845	.3159	.0683
17	.0806	.0482	.0470	418 (1)	.2934	.3293	.0683
49	.0896	.0504	.0470	540			.0762
98	.0963	.0695	.0482	706			.0874
142	.1042	.0806	.0538	935			.1176
172	.1120	.0930	.0571	995			.1310
199	.1221	.1019	.0571	1058			.1422
234	.1366	.1198	.0594	1094			.1568
256	.1478	.1366	.0594	1146			.1680
296	.1702	.1658	.0616	1147 (2)	.2934	.3293	.1680
328	.1994	.1971	.0616				
344	.2150	.2173	.0627				
357	.2240	.2341	.0627				
367	.2363	.2475	.0638				
377	.2419	.2598	.0638				
385	.2487	.2744	.0661				
393	.2576	.2912	.0661				
401	.2632	.3035	.0683				

(1) STOP-DRILLED HOLE #1 & #2
(2) FAILURE @ HOLE #1

TABLE 117- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VBA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-3,
THICKNESS(INCH) 0.379,
WIDTH (INCH) 3.999,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 1.00
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0042", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0616	.0549	.0358	468	.3282	.1456	.2610
26	.0728	.0616	.0437	484	.3282	.1568	.2610
59	.0840	.0627	.0594	502 (2)	.3282	.1680	.2610
89	.0952	.0638	.0627				
130	.1151	.0683	.0851				
151	.1288	.0706	.1030				
171	.1467	.0728	.1142				
188	.1736	.0750	.1266				
214	.1814	.0784	.1512				
234	.2061	.0795	.1691				
245	.2195	.0795	.1792				
255	.2386	.0806	.1915				
266	.2542	.0818	.2072				
276	.2710	.0896	.2229				
285	.2856	.0907	.2341				
305 (1)	.3282	.0918	.2610				
366	.3282	.1075	.2610				
414	.3282	.1198	.2610				
440	.3282	.1310	.2610				

(1) STOP-DRILLED HOLE #1 & #3

(2) DISCONTINUED TESTING, TEST MACHINE FAILED

TABLE 118 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6Al-4VβA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-4,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 4.001,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_t/\sigma_o = 1.00$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_t/\sigma_o = 0$
HOLE #3 4% C.W. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0672	.0560	.0571	1081	.2475	.2598	.0907
38	.0750	.0571	.0672	1092	|	.2688	.0907
179	.0840	.0594	.0672	1103	|	.2811	.0918
240	.0975	.0694	.0683	1115	|	.2923	.0918
371	.1176	.0762	.0706	1128	|	.3069	.0930
406	.1322	.0773	.0706	1140	|	.3226	.0930
511	.1512	.0818	.0739	1150 ②	|	.3405	.0930
589	.1803	.0862	.0762	1316	|	|	.1075
610	.1938	.0930	.0762	1426	|	|	.1255
643	.2117	.1008	.0773	1487	|	|	.1434
679	.2307	.1030	.0784	1554	|	|	.1635
703 ①	.2475	.1075	.0795	1601	|	|	.1859
801	|	.1232	.0795	1642	|	|	.2106
854	|	.1355	.0806	1683	|	|	.2654
888	|	.1478	.0806	1711	.2475	.3405	.3002
919	|	.1624	.0840				
960	|	.1803	.0851				
1004	|	.2038	.0874				
1030	|	.2251	.0885				
1061	.2475	.2442	.0896				

① STOP - DRILLED HOLE #1
② STOP - DRILLED HOLE #2

TABLE 19 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. I-FS-5,
THICKNESS(INCH) 0.380,
WIDTH (INCH) 4.001,

HOLE #1 5% c.w. - open
HOLE #2 5% c.w. - open
HOLE #3 4% c.w. - open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0616	.0336	.0246	265	.3270	.0874	.1994
23	.0739	.0437	.0336	276		.0896	.2173
63	.0851	.0560	.0482	293		.0941	.2487
84	.0986	.0583	.0538	304		.0963	.2688
108	.1142	.0627	.0650	324 ②		.1030	.3058
130	.1288	.0638	.0717	375		.1142	
149	.1478	.0661	.0840	391		.1277	
159	.1624	.0683	.0907	404		.1422	
170	.1803	.0695	.0963	418		.1546	
179	.1926	.0706	.1030	432		.1702	
185	.2027	.0717	.1064	448		.1893	
192	.2106	.0728	.1131	471		.2094	
200	.2240	.0739	.1198	479 ③	.3270	.2162	.3058
207	.2341	.0750	.1266				
214	.2453	.0762	.1344				
220	.2598	.0773	.1434				
227	.2688	.0784	.1490				
233	.2811	.0795	.1557				
242	.3125	.0806	.1714				
253 ①	.3270	.0840	.1826				

① STOP-DRILLED HOLE # 1 ② STOP-DRILLED HOLE # 3
③ FAILURE @ HOLE #;

TABLE 120- GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN GAR-4V BA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-6,
THICKNESS(INCH) 0.376,
WIDTH (INCH) 4.003,

HOLE #1 2% c.w., Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c.w., Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w., Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
17	.0650	.0739	.0515	237 ⚠	.4222	.3618	.2061
34	.0762	.0818	.0560	245			.2150
54	.0896	.0918	.0627	253			.2296
71	.1086	.1019	.0683	261			.2475
84	.1187	.1221	.0773	269			.2654
102	.1310	.1299	.0806	282	.4222	.3618	.2912
124	.1658	.1523	.0907				
136	.1770	.1725	.0997				
147	.1926	.1859	.1109				
157	.2128	.1994	.1176				
167	.2307	.2162	.1243				
177	.2554	.2386	.1333				
185	.2733	.2412	.1389				
193	.2934	.2632	.1478				
200	.3080	.2811	.1568				
207	.3203	.2890	.1635				
214	.3438	.3013	.1725				
222	.3718	.3170	.1837				
229	.3898	.3304	.1926				

⚠ STOP-DRILLED HOLES #1 & #2.

TABLE 121 - GROWTH BEHAVIOR OF CORNER CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VβA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-7,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 4.000,

HOLE #1 2% C.W, Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% C.W, Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% C.W. - open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0650	.0695	.0638	228	.3439	.2117	.1702
8	.0762	.0728	.0683	242	.3439	.2318	.1803
27	.0918	.0784	.0717	259	.3439	.2430	.2016
48	.1030	.0829	.0762	270	.3439	.2509	.2106
58	.1142	.0851	.0784	276 (2)	.3439	.2554	.2162
83	.1277	.0997	.0862				
100	.1378	.1042	.0907				
121	.1893	.1142	.0986				
128	.1960	.1165	.1042				
135	.2050	.1187	.1053				
143	.2184	.1198	.1075				
150	.2296	.1210	.1131				
156	.2464	.1210	.1165				
162	.2598	.1221	.1198				
167	.2710	.1490	.1243				
173	.2822	.1568	.1254				
178	.2946	.1613	.1299				
183	.3293	.1658	.1355				
189 (1)	.3439	.1814	.1411				
205	.3439	.1882	.1546				

(1) DISCONTINUED READING HOLE #1
(2) FAILURE HOLE #1

3.4 Fighter Spectrum - Thru Cracks

TABLE 122- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-8,
THICKNESS(INCH) 0.377,
WIDTH (INCH) 5.015,

HOLE #1 Neat-Fit, Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 Open Hole

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0034	.0101	.0157	234	.2699	.2822	.3651
3	.0112	.0146	.0224	243	.3046	.2901	.3853
7	.0179	.0190	.0258	248 (1)	.3080	.3002	.3965
11	.0258	.0202	.0336	254	.3058	.3136	.4032
15	.0291	.0392	.0336	260	.3192	.3237	.4166
21	.0370	.0448	.0471	269	.3506	.3382	.4323
30	.0526	.0459	.0504	281	.3920	.3651	.4704
40	.0594	.0571	.0583	287	.4099	.3797	.4895
55	.0638	.0538	.0806	296 (2)	.4469	.4099	.5096
68	.0739	.0650	.0952	301	.4648	.4166	.5096
83	.0974	.0784	.1176	310	.5130	.4647	.5096
102	.0963	.0997	.1478	317	.5522	.4659	.5096
113	.1086	.1165	.1602				
134	.1210	.1333	.1949				
151	.1400	.1478	.2240				
164	.1602	.1669	.2442				
179	.1690	.1904	.2610				
197	.1926	.2106	.2912				
212	.2341	.2330	.3203				

(1) CRACK BEGINING TO FORK AT HOLE #2
(2) STOP-DRILLED HOLE #3

TABLE 123- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VβA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-9,
THICKNESS(INCH) 0.377,
WIDTH (INCH) 5.014,

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 0.96
HOLE #2 TL #1, δ = 0.0034", σ_b/σ_o = 0
HOLE #3 TL #1, δ = 0.0034", σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0056	.0045	.0090				
24	.0056	.0045	.0090				
155	.0056	.0045	.0090				
206	.0056	.0045	.0090				
253	.0056	.0045	.0090				
325 (1)	.0056	.0045	.0090				

(1) TESTING DISCONTINUED

TABLE 124 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN CAL-4V BA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-10,
THICKNESS(INCH) 0.375,
WIDTH (INCH) 4.002.

HOLE #1 TL #2, δ = 0.0042", σ_b/σ_o = 1.00
HOLE #2 TL #2, δ = 0.0042", σ_b/σ_o = 0
HOLE #3 TL #2, δ = 0.0042, σ_b/σ_o = 0

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0806	.0695	.0638	362	.3629	.3170	.2643
49	.1142	.0840	.0750	370 (1)	.3629	.3170	.2722
70	.1299	.0918	.0762				
90	.1456	.1008	.0784				
111	.1613	.1098	.0874				
125	.1814	.1176	.0930				
135	.1904	.1254	.0952				
153	.2072	.1400	.0997				
173	.2274	.1568	.1075				
190	.2464	.1736	.1154				
205	.3170	.1926	.1299				
226 (2)	.3629	.2274	.1389				
241	|	.2610	.1445				
253	|	.2834	.1512				
267 (2)	|	.3170	.1590				
300	|	|	.1792				
321	|	|	.1960				
340	|	|	.2274				
350	.3629	.3170	.2397				

(1) FAILURE HOLE #1 (2) STOP-DRILLED HOLE #2
(2) STOP-DRILLED HOLE #1

TABLE 125- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-11 ,
THICKNESS(INCH) 0.376 ,
WIDTH (INCH) 4.003 ,

HOLE #1 Only Two Test Holes
HOLE #2 2% C.W., Neat-F.t, σ_b/σ_o = .
HOLE #3 2% C.W., Open

TOTAL FLIGHTS	CRACK LENGTH, , INCH			TOTAL FLIGHTS	CRACK LENGTH, , INCH		
	HOLE #1	HOLE #2	HOLE #3		HOLE #1	HOLE #2	HOLE #3
0	.0000	.0067	.0079	206	.0000	.3584	.1960
23		.0067	.0190	223			.2094
49		.0067	.0280	242			.2464
72		.0067	.0392	258			.2979
87		.0392	.0448	270	.0000	.3584	.3203
103		.0470	.0549				
116		.0650	.0627				
127		.0851	.0739				
134		.1221	.0784				
141		.1456	.0818				
148		.1635	.0885				
155		.1859	.0452				
162		.2027	.1030				
169		.2374	.1098				
175		.2576	.1198				
180		.2733	.1266				
185		.3002	.1299				
190		.3203	.1389				
195		.3461	.1523				
200 ⚠1	.0000	.3584	.1602				

⚠1 STOP-DRILLED HOLE # 2

TABLE 126- GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4VBA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-12,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 4.002,

HOLE #1 2% c.w, Load Transfer, $\sigma_b/\sigma_o = 1.0$
HOLE #2 2% c.w, Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c.w, open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0045	.0090	.0079	228	.2565	.2486	.1770
20	.0157	.0123	.0112	233	.2565	.2576	.1893
31	.0358	.0168	.0168	238	.2565	.2778	.2083
43	.0504	.0202	.0213	241	.2565	.2890	.2206
55	.0862	.0235	.0280	248	.2565	.3203	.2341
68	.1030	.0291	.0291	256	.2565	.3315	.2520
80	.1221	.0325	.0302	262	.2565	.3472	.2632
95	.1725	.0403	.0314	269	.2565	.3685	.2789
104	.2038	.0437	.0325	279	.2565	.3987	.3147
117	.2363	.0582	.0415				
123 ①	.2565	.0627	.0415				
143	.2565	.0784	.0482				
153	.2565	.1008	.0560				
163	.2565	.1221	.0638				
173	.2565	.1322	.0773				
183	.2565	.1557	.0975				
193	.2565	.1658	.1087				
203	.2565	.1814	.1232				
213	.2565	.2072	.1490				
223	.2565	.2352	.1658				

① STOP-DRILLED HOLE #1

TABLE 127- GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *6Al-4V βA TITANIUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. *T-FS-13*,
THICKNESS(INCH) *0.378*,
WIDTH (INCH) *4.004*,

HOLE #1 *2% c.w., Load Transfer,* $\sigma_b/\sigma_o = 1.00$
HOLE #2 *2% c.w., Neat-Fit,* $\sigma_b/\sigma_o = 0$
HOLE #3 *2% c.w., open*

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.0112	.0023	.0079	151	.3159	.3214	.2744
12	.0224	.0023	.0179	156 (2)	.3338	.3214	.2890
25	.0347	.0168	.0224	161	.3338	.3214	.3069
38	.0504	.0672	.0302	166	.3338	.3214	.3203
48	.0605	.0840	.0403				
62	.0795	.1254	.0605				
68	.0896	.1344	.0661				
75	.1042	.1534	.0717				
84	.1232	.1758	.0918				
94	.1490	.1982	.1142				
101	.1691	.2251	.1288				
106	.1814	.2374	.1389				
111	.1994	.2598	.1579				
116	.2106	.2722	.1658				
121	.2195	.2822	.1759				
126	.2296	.2957	.1904				
131	.2419	.3114	.2094				
136 (1)	.2598	.3214	.2318				
141	.2856	.3214	.2487				
146	.2968	.3214	.2598				

(1) STOP-DRILLED HOLE #2

(2) STOP-DRILLED HOLE #1

TABLE 128 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-14,
THICKNESS(INCH) 0.375,
WIDTH (INCH) 4.000,

HOLE #1 2% c w, Load Transfer, $\sigma_b/\sigma_o = 1.00$
HOLE #2 2% c w, Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% c w, open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0370	.0560	.0246	135	.3528	.3270	.2173
10	.0728	.0762	.0426	140			.2296
23	.0930	.0952	.0515	145			.2386
37	.1187	.1176	.0571	150			.2475
48	.1378	.1400	.0706	155			.2587
59	.1669	.1568	.0784	160			.2722
66	.1859	.1646	.0851	165			.2901
72	.2072	.1904	.0941	170			.3080
79	.2240	.1938	.0997	175			.3192
85	.2442	.2072	.1086	180	.3528	.3270	.3338
89	.2520	.2139	.1221				
95	.2733	.2274	.1299				
100	.2856	.2386	.1422				
105	.3203	.2531	.1490				
110	.3304	.2733	.1546				
115	.3528	.2912	.1635				
120	.3528	.3046	.1758				
125	.3528	.3147	.1870				
130 ①	.3528	.3270	.2061				

① STOP-DRILLED HOLES #1 & #2

TABLE 29 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V BA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-15,
THICKNESS(INCH) 0.379,
WIDTH (INCH) 5.006,

HOLE #1 2% C.W., Load Transfer, $\sigma_b/\sigma_o = 1.01$
HOLE #2 2% C.W., Neat-Fit, $\sigma_b/\sigma_o = 0$
HOLE #3 2% C.W., Oper.

TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, , INCH HOLE #1	HOLE #2	HOLE #3
0	.1210	.1653	.1702	164	.4323	.4771	.4995
6	.1534	.1792	.1960	171	.4514	.4850	.5197
10	.1714	.1837	.2150				
15	.1770	.1 4	.2117				
26	.1848	.2038	.2262				
31	.1893	.2106	.2330				
42	.1982	.2330	.2520				
53	.2139	.2554	.2688				
65	.2274	.2722	.2923				
75	.2464	.2946	.3080				
98	.2755	.3282	.3494				
109	.3226	.3696	.3763				
120	.3427	.3875	.4278				
126	.3573	.4144	.4391				
132	.3674	.4189	.4402				
138	.3864	.4480	.4503				
144	.3976	.4503	.4547				
150	.4010	.4514	.4659				
158	.4178	.4671	.4895				

TABLE/3c- GROWTH BEHAVIOR OF *THRU* CRACK EMANATING FROM VARIOUS FASTENER HOLES IN *6AL-4V βA TITANIUM* ALLOY PLATE SUBJECTED TO *FIGHTER* SPECTRUM LOADING

SPECIMEN NO. *T-ES-16*,
THICKNESS(INCH) *0.381*,
WIDTH (INCH) *3.999*,

HOLE #1 *TL #3, δ=0.0050", $\sigma_b/\sigma_o = 0$*
HOLE #2 *TL #3, δ=0.0050", $\sigma_b/\sigma_o = 0$*
HOLE #3 *4% C.W. - open*

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0347	.0269	.0403	650	.2352	.1523	.1635
70	.0391	.0269	.0504	660		.1647	.1702
93	.0403	.0302	.0627	670		.1747	781
140	.0403	.0415	.0627	680		.1826	.1893
199	.0426	.0437	.0627	690		.1904	.1994
261	.0482	.0482	.0627	700		.1994	.2106
344	.0493	.0538	.0694	710		.2094	.2274
415	.0515	.0616	.0784	720		.2173	.2419
478	.0963	.0695	.0874	730		.2341	.2587
489	.1064	.0717	.0930	737		.2453	.2744
511	.1310	.0739	.0974	744		.2531	.2872
529	.1378	.0784	.1042	750		.2621	.3013
550	.1635	.0851	.1098	755		.2699	.3080
567	.1725	.0952	.1210	761 ②		.2867	.3304
586	.1982	.1075	.1255	767		.3013	.3304
609	.2229	.1210	.1333	773	.2352	.3069	.3304
618 ①	.2352	.1277	.1378				
630	.2352	.1367	.1456				
640	.2352	.1411	.1568				

① STOP-DRILLED HOLE #1
② STOP-DRILLED HOLE #3

TABLE (3) - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V/BA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING

SPECIMEN NO. T-FS-17,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 3.900,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_t/\sigma_o = c$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_t/\sigma_o = 0$
HOLE #3 4% c w - open

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
0	.0482	.0235	.0638	276	.1266	.0381	.2800
20	.0504	.0246	.0739	297	.1366	.0403	
69	.0515	.0246	.0885	313	.1590	.0448	
96	.0527	.0258	.0986	323	.1736	.0448	
128	.0605	.0258	.1131	345	.2027	.0482	
149	.0706	.0258	.1254	358	.2184	.0493	
165	.0784	.0258	.1445	367	.2397	.0504	
175	.0806	.0258	.1646	380	.2666	.0538	
180	.0818	.0258	.1714	389	.2890	.0549	
186	.0829	.0258	.1826	397	.3002	.0583	
191	.0840	.0258	.1904	405	.3136	.0583	
200	.0874	.0280	.2027	413	.3293	.0583	
208	.0896	.0280	.2128	421 (2)	.3551	.0616	
214	.0907	.0280	.2296	454	|	.0706	
219	.0918	.0280	.2430	467	|	.0706	
224	.0930	.0280	.2587	477	|	.0862	
229	.0952	.0280	.2688	487	|	.0930	
234 (1)	.0974	.0280	.2800	501	|	.0997	
252	.053	.0381	.2800	515	|	.1120	
				530	.3551	.1254	.2800

(1) STOP-DRILLED HOLE #3
(2) STOP-DRILLED HOLE #1

(CONT.)

TABLE 131 - GROWTH BEHAVIOR OF THRU CRACK EMANATING FROM VARIOUS FASTENER HOLES IN 6AL-4V βA TITANIUM ALLOY PLATE SUBJECTED TO FIGHTER SPECTRUM LOADING (CONTINUED)

SPECIMEN NO. T-FS-17,
THICKNESS(INCH) 0.378,
WIDTH (INCH) 3.900,

HOLE #1 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0$
HOLE #2 TL #3, $\delta = 0.0050"$, $\sigma_b/\sigma_o = 0$
HOLE #3 4% CW - open

(CONT.)

TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3	TOTAL FLIGHTS	CRACK LENGTH, INCH HOLE #1	HOLE #2	HOLE #3
548	.3551	.1613	.2800				
554	|	.1624	|				
562	|	.1792	|				
566 (3)	.3551	.1826	.2800				

(3) FAILURE @ HOLE #1